ANALYSIS OF THE NEXT GENERATION
SMALL LOADER (NGSL) IN REDUCING
THE MOBILITY FOOTPRINT

THESIS

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AFIT/GLM/ENS/01M-01

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AFIT/GLM/ENS/01M-01

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THESIS

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Transportation Management

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March 2001

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED

AFIT/GLM/ENS/01M-01

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Acknowledgements

I wish to take this opportunity to express my gratitude to the members of my thesis committee, Dr. William A. Cunningham, and Major Mark Ward, for their wisdom, counsel, and expert advice in helping me complete my AFIT thesis, as well as helping me through the demanding and rigorous requirements of the AFIT experience.

Lieutenant Colonel Paul Stipe and Major Keith Fletcher, of the Wright-Patterson Next Generation Small Loader (NGSL) Program Office, provided tremendous help in obtaining information on the NGSL, as information became available. Additionally, Major Michael Crupe and Captain Jeff Russell, at Air Mobility Command (AMC) Headquarters, provided a fountain of information on the NGSL, ranging from raw data to points of contact. I also wish to thank Master Sergeant Kim Green and the many members of the 436th Aerial Port Squadron and 436th Transportation Squadron, Dover Air Force Base, Delaware, who provided much-needed data for the completion of this thesis.

Without the support and encouragement of my family, I would not have been able to complete this project. My wife and three-year-old son have supported me throughout my endeavors, and their dedication has been the bedrock of my career, and the motivation for completing the AFIT program. I also wish to acknowledge my other children, who are not with us, but are constantly on my mind.

Above all others, I thank Jesus Christ for his gift of salvation, hope, and grace in my life.

Victor Anthony "Tony" Anaya

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Abstract

The impact the Next Generation Small Loader (NGSL) will have on reducing the mobility footprint has not been thoroughly explored. The global mobility system cannot function without adequate Materiel Handling Equipment (MHE). MHE of the future must be multi-purpose in design and should able to support multiple weapon systems. In addition, it will require less maintenance and be easier to deploy thus making air mobility operations more responsive to customer needs. Current MHE is old and labor intensive. The Air Mobility Command's (AMC's) small loaders, especially 25K loaders, are in very poor condition and are incapable of servicing KC-10s and commercial wide-body aircraft. AMC's fleet of wide-body elevator loaders (WBELs) are capable of servicing commercial wide-body aircraft, but have also exceeded their designed service life. Both the 25K loader and WBEL require replacement with a more reliable and flexible loader. AMC is currently exploring a Non-developmental Item (NDI) loader in the NGSL. This loader will be capable of servicing KC-10s and commercial wide-body aircraft.

The NGSL combines the capabilities of the 25K loader and the WBEL. This technology, coupled with the new Tunner 60K loader, will improve cargo loading and unloading efficiency by providing highly mobile, flexible, and reliable MHE capable of servicing all types of cargo aircraft. This study is an analysis of how the NGSL will benefit cargo-loading operations by reducing the mobility footprint, in terms of manpower, operating cost, aircraft loading times, aircraft capacity, and vehicle authorizations.

ANALYSIS OF THE NEXT GENERATION

SMALL LOADER (NGSL) IN REDUCING

THE MOBILITY FOOTPRINT

I. Introduction

Overview

The Next Generation Small Loader (NGSL) is an air transportable, 25,000-pound capacity, self-propelled mobile air cargo transporter/loader that can support all military transport and Civil Reserve Air Fleet (CRAF) cargo aircraft (21:1). The loader is capable of interfacing with all main deck and lower-lobe cargo doors of all commercial and military cargo aircraft. The loader has drive on/off capability, thus enhancing air transportability on C-130, C-141, C-5 and C-17 military aircraft. The loader will be used to move cargo between loading areas and the aircraft. The NGSL is capable of obtaining speeds of at least 15 miles per hour, and has the capability to traverse paved asphalt covered by sand, rain, mud, sleet, or snow, as well as dirt, and gravel (21:1). The deck of the NGSL has a powered roller system, and is compatible with military 463L pallets and rolling stock, and has a deck height service range from 39 to 220 inches (18:1). The deck length, as a minimum, "is capable of accommodating three 463L pallets with the 108-inch dimension traversing the deck width", or commonly referred to as the 108-inch bias (21:1).

The Air Mobility Command (AMC), as well as other Air Force Major Commands (MAJCOMs), is responsible for on- and off-loading military and commercial aircraft supporting National Command Authority (NCA) and Joint Chiefs of Staff (JCS) taskings

(21:1). Currently, this is accomplished using many different types of Materiel Handling Equipment (MHE). The four basic types of cargo loaders are the 25,000-pound (25K) capacity loader, 40K loader, the Wide Body Elevator Loader (WBEL), and the Tunner 60K loader. Many of the 25K Loaders have exceeded their service life expectancy and are sustained by continual depot overhaul and intensive intermediate maintenance. Since June of 2000, over 53 percent of the small loaders of the 685 25K loaders in the inventory, were replacement eligible (21:1). Overhaul programs have extended the life of only a portion of the loader inventory. In addition, heavy use during increased air mobility taskings has led to structural metal fatigue and frame cracks in nearly 57 percent of the 40K loaders and 68 percent of the 25K loaders (21:1).

Table 1. Aging Cargo Loader Fleet

Type Loader	MTBF (Hours)	Life Expectancy (Years)	Average Age (Years)
40K Loader	10	8	16
25K Loader	13	10	8
WBEL	4	10	10

Source: Tim Ringler and Wid Hall. Small Cargo Loader Study. Nichols Research Corporation, Huntsville, AL. October 1994. P. 2-2.

Although the 25K loader interfaces with C-5, C-17, C-130, C-141, and KC-135 aircraft, its 13-foot maximum lifting height is a serious limiting factor when the Air Force employs commercial wide-body aircraft, which require a reach of 18 feet (21:1). WBELs answer this deficiency by elevating up to two pallets up to the wide-body aircraft floor. However, WBELs do not transport cargo. Other vehicles are required to move loads to and from the loading area, thus increasing the number of loading vehicles, which must be deployed, to handle cargo. Because WBELS have currently exceeded their life

expectancy by an average of 12 years, maintainability of the WBEL fleet grows more difficult. Lower lobe loaders are used to service the lower cargo compartments of large commercial aircraft. This additional equipment increases the expense and logistics tail of mobility operations (21:1).

Source selection in the development of the NGSL program began in October 1998 when the Air Force awarded Phase I contracts to FMC Corporation, of Orlando, Florida, and Teledyne Brown Engineering, of Huntsville, Alabama, for the production and the support of three prototype loaders in a formal test program (21:1). The test program included a 4-month Contractor Test and a 3-month Government Operational Test. The test program was completed on 6 December 1999 (21:1). These two loaders were selected for Phase I because they were the only loaders that met many of the NGSL requirements without the need for extensive research and development efforts. On 22 June 2000, FMC Corporation was awarded a $458,000,000 (maximum) indefinite-delivery/indefinite-quantity contract to provide for 264 (best estimated quantity) NGSLs, with up to fifteen years of logistics support (21:2). The Air Force can issue delivery orders for loaders and logistics support totaling up to the maximum amount indicated above, though actual requirements may necessitate less than that amount. According to Major Keith Fletcher (2001), NGSL Program Office Deputy Director, FMC plans to deliver the 264th loader at the end of calendar year 2004 (10:1).

Background on the Development of the NGSL

As of FY00, the NGSL ranked as the seventh of AMC's most important acquisition programs (4:11). In a presentation to the House National Security Committee, Subcommittee on Military and Procurement and Subcommittee on Research

and Development (March 1998), Lieutenant General George K. Muellner, Principal Deputy Assistant of the Air Force for Acquisition, stated,

> "The hinge pin for Rapid Global Mobility is the ability to efficiently and reliably on and off load both commercial and military aircraft, and then get the cargo to the warfighters. Our current fleet of Materiel Handling Equipment (MHE) is showing its age and does not efficiently support wide-body commercial aircraft operations. The NGSL will provide the versatility to load wide-body commercial aircraft as well as be transportable by C-130 aircraft to support mobility operations at forward bases." (20:47)

The NGSL will replace 264 25K loaders and approximately 59 WBEL authorizations (4:11). Requirement specifications state the NGSL will handle three cargo pallets with a 25,000-pound capacity, and be air transportable aboard C-130, C-141, C-5, and C-17 aircraft. AMC and the Air Staff decided to acquire a loader already developed through a Non-developmental Item (NDI) acquisition program, instead of developing a totally new loader (4:11). Between November of 1996 and January of 1997, the Air Force Operational Test and Evaluation Center (AFOTEC) tested two cargo loaders, the British Atlas and the Australian TASLU loaders, at Travis Air Force Base, California, and concluded that although neither variant met the needs of the Air Force, minor modifications of either loaders could meet the requirements (18:1).

On 10 March 1998, the Principal Deputy Assistant Secretary of the Air Force for Acquisition and Management, Darleen Druyun, designated Brigadier General Richard Reynolds as the NGSL program executive officer (PEO) (4:11). In May of 1998, program responsibility for executing the source selection and contract award transferred from the Warner-Robins Air Logistics Center to the Aeronautical Systems Center (ASC) at Wright-Patterson Air Force Base, Ohio (4:11). According to Major Michael Crupe

(2000), "the AMC Commander, General Walter Kross, expressed concern that the NGSL program was not progressing as quickly as predicted" (4:11). General Kross considered delivery of the loaders critical to AMC's mission. The cause of the production delay may have been due to some design specifications of one of the competitiors. The British Atlas loader did not have the capability to side-shift its platform, as required by AMC, although the loader's front and rear wheels could steer in a crabbing motion to the side. However, the problem remained that any lateral crabbing motion directly depended upon clearance for longitudinal mobility. For every inch of lateral deck movement, one inch of longitudinal movement was required for positioning (10:1). AMC contended that it needed the loaders to have the capability to side-shift because this would allow the loader operator to move the loader forward when it is up against an aircraft. Warner-Robins indicated that AMC's requirement would have to go back to the contractors, thus costing more money, and requiring more engineering (4:11). This resulted in the British Embassy conducting its own study and indicating the Royal Air Force (RAF) found the loaders to be acceptable. However, the RAF does not own C-141, C-5, or other aircraft with t-tail doors. Druyun directed the change to ASC from Warner-Robins, because she felt ASC was better-suited in dealing with some of the program's challenges. In July 1998, a program update and ASC strategy briefing was presented to Lieutenant General Robert Raggio, ASC Commander (4:12). The changeover required some time for those reassigned from the C-17 Systems Projects Office (SPO) to get up to speed on the NGSL program. Crupe states that "the changeover did produce results, as the source selection and contract award occurred slightly more than 30 days earlier than scheduled" (4:12).

Testing was completed at the beginning of 1997, and the contractors were pressing for the release of the request for proposal. One of the changes recommended by the Wright-Patterson SPO was to do away with side tine troughs as a hard requirement, and to do away with the nuclear certification, thus to be more in line with an NDI and to cut development modification costs (10:1). However, a constant AMC requirement was to develop the capability to upload or download pallets without manually having to push the pallet off, spin it and then turn it, as was the capability with the Tunner 60K Loader (4:12). The design specification for the NGSL would allow for the handling of 463L pallets in both the normal 108-inch bias and the new 88-inch bias, now standard on the C-17. The NGSL was then designated an Acquisition Category (ACAT) III program, placing milestone decision authority at the lowest level (4:12).

The Air Force selected the NGSL program for the Reduction in Total Ownership Cost (R-TOC) Pilot Program in August of 1998, which was a new DoD initiative (4:12). The program attempted to capture the decisions that were made up front in the design or development process that would help lower cost. The emphasis of the NGSL program was on reliability changes and logistics support. Participation in the DoD initiative meant the development of R-TOC implementation plans, which established the program's baseline cost, defined reduction initiatives, set milestones, and identified metrics for measuring progress (25:3).

The NGSL Acquisition Strategy Panel approved the program's entrance into Phase I in April 1998, which encompassed the building and testing of the pre-production loaders. Phase II would encompass the production contract, with a provision for the Air Force to enhance the performance and capability of the loaders via a pre-planned product

improvement (3PI) program. Crupe states that changes to the operational requirements document were issued in June of 1998 (4:13). These changes recommended by the SPO to AMC, included adjusting the maximum grade of travel to five degrees, versus the more restrictive 10 degrees, deleting bridge plates as a cost savings, and specifying operating and storage temperature threshold objectives (4:13). AMC's Studies and Analysis Flight (XPY) also validated ASC's pallet movement estimate of "100 pallets per day per loader" (15:2).

The Air Force issued the final request for proposal to potential contractors on 1 July 1998 (4:13). The industry partners, which expressed interest in the requests, were FMC Corporation, Teledyne Brown Engineering, System and Electronics, Inc., Accessory Controls and Equipment, and RAHCO International (4:13). FMC, Teledyne Brown, and Systems Electronics were serious bidders. RAHCO International, which teamed with PERRY Engineering to form Advanced Transport Vehicles, dropped out of the competition and offered to AMC its Truck-Aircraft Loading, Off Pavement (TACLOP) loader as a commercial off -the-shelf (COTS) item. The TACLOP had been developed for the Australian Army as an air transportable, all-terrain aircraft loader/unloader. However, it was not selected. The NGSL Source Selection Team spent six weeks reviewing the proposals (4:14). On 24 September 1998, Lieutenant General Raggio chaired the first of two source selection authority meetings. At this time, the British Atlas proposal included another offer to produce their loader without the side-shifting capability, which was also rejected (4:14).

ASC awarded contracts to FMC Corporation, of Orlando, Florida, and Teledyne Brown Engineering (TBE), of Huntsville, Alabama on 28 October 1998 (4:14). Each

corporation was tasked to build three pre-production loaders. Each corporation offered significantly different loaders. The NGSL program was back on track, with a new baseline, and there was a sense of confidence that it could be held to a new schedule. An Operational Assessment (OA), to determine the best loader, was scheduled to begin in the fall of 1999 (4:14). All operational testing was scheduled for completion by April of 2000, with the awarding of the NGSL contract to follow on 1 June 2000 (4:14). The first delivery of the NGSL was projected for January of 2001 (4:14).

Research Objectives

The primary research objective is to analyze whether the NGSL will reduce the mobility footprint. A reduction in the mobility footprint will allow for increased efficiency in cargo-loading operations, during both peacetime and wartime conditions. To achieve this goal, the research will examine the following investigative questions:

a) Is there a difference in manpower needed to operate and maintain the NGSL compared to the 25K loader?

b) Is there a reduced operating cost of the NGSL, compared to the current cost of operating and maintaining the 25K loader?

c) Does the NGSL help reduce ground cargo-loading times compared to the 25K loader and WBEL?

d) Does the NGSL affect aircraft capacity?

e) Does the NGSL affect current authorizations?

Chapter Overview

Chapter II is a review of the literature concerning the need for the development of a new generation of MHE that will provide greater flexibility and efficiency in cargo-

loading operations. Chapter III explains the methodology used to describe how the NGSL will benefit cargo-loading operations through the reduction of the mobility footprint. Chapter IV examines the data presented in determining the benefits of the reduction of the mobility footprint, as discussed in Chapter III. Finally, Chapter V provides a conclusion of the data analysis, provides the limitations of the research, and provides recommendations for future applications of the NGSL.

II. Literature Review

Overview

The literature review contained in this chapter deals with several important studies, which were conducted between 1983 and 1996. These studies outline the current capabilities of the MHE fleet. Each study deals with separate issues, such as the management of the MHE fleet, design capabilities of a new loader, deficiencies of the current fleet of MHE, and future MHE requirements. The common thread among the authors of the following studies is that the Air Force must develop a new loader to meet the challenges of a more mobile force.

The Impact of MHE on Aircraft Capabilities

The May Study

Lieutenant Colonel Gary B. May (1983), in his Air University study entitled The Impact of Materials Handling Equipment on Aircraft Capabilities, discusses several aspects of why the United States Air Force has not properly managed its MHE fleet, why the Air Force does not utilize its current MHE fleet to its fullest potential, and why the Air Force must consider developing and procuring newer models of MHE to meet mission needs. May states the development of the 463L pallet and net system was a huge step toward creating a more efficient cargo loading system. However, May also states that as aircraft technology rapidly developed, technology for MHE did not advanced (16:2).

May states that the current 25K and 40K loaders have not lived up their potential because they failed to perform as desired. The development of the 463L system of cargo

pallets, nets, and compatible MHE and aircraft was a giant step forward in realizing the potential of new large-volume aircraft. However, the Vietnam conflict provided examples as to why current MHE failed to meet the expectations of senior Air Force leadership. May states that difficulty in obtaining spare parts in a combat zone, low MHE reliability rates, and operating in austere environments contributed to the MHE not reaching its full potential (16:26). May recommends that the current fleet of MHE should be replaced (16:103). May states the use of the same MHE currently in existence reinforces the disparity between the development of advanced aircraft and the lack of development of an effective MHE loading capability (16:103).

The Douglas Study

During the 1950s, the Lockheed Aircraft Corporation was involved in studies for the development of a pallet system in their C-130 aircraft. At the same time, the Douglas Aircraft Company was developing its own rapid loading system for the C-133 aircraft (16:22). The Douglas Aircraft Company conducted a study in the 1960s of the 463L Materiel Handling Support Equipment. The 463L pallet and net system formed the basis by which the majority of materiel handling equipment was developed. The 463L pallet was designed to fit on all current U.S. Air Force cargo aircraft (16:22). The Douglas study agreed that "the controlling element of the entire 463L System is the materiel handling pallet and cargo net" (9:4). As soon as the pallet concept was agreed upon, the Air Force and the commercial aircraft industry had to come to an agreement on the common size of the pallet. The decision was based on a compromise between the land transportation business and the air transportation business. The decision to make the pallet 88 inches by 108 inches was the best compromise for air cargo movement,

considering the types of aircraft in service at the time (16:22). The width of the cargo doors and cargo decks of the aircraft were key factors in developing the dimensions of the pallet. Additionally, pallets that measured 88 inches by 108 inches would readily fit into railroad boxcars (110 inches), in all types of van containers, and on flatbed trucks (15:22).

The 436L pallet offered many advantages. Pallets reduced the number of times cargo had to be handled. Cargo could now be piled up on a pallet, thus making transportation of cargo more efficient. Pallets also offered a means to restrain the cargo by using a system of nets and tie-down straps. This made the storage of cargo enroute to its final destination very efficient. Most importantly, the development of the 463L pallet meant the Air Force could achieve a large measure of interoperability (16:22). The 463L pallet would not only tie the civil and military airlift systems together, but would link land transportation into the network, as well. The 463L pallet was "approved on an interim basis by the American Standards Association as the standard size pallet for all American transportation" (9:3).

Although the development of the 463L pallet vastly improved the management of cargo movement, there were still many problems with the transportation of cargo between the warehouse and the aircraft. The Vietnam conflict is a prime example of the problems faced with MHE. The Douglas study states the major problem associated with the movement of cargo from warehouses to the aircraft was mainly due to low MHE reliability, specifically, lack of spare parts (16:25). The three major aerial ports in Vietnam at that time were the 15th Aerial Port Squadron in Da Nang, the 14th Aerial Port Squadron in Camrahn Bay, and the 8th Aerial Port Squadron in Tan Son Nhut (16:25). It

was not uncommon for these ports to wait up to 30 days for the delivery of parts. By January 1967, the situation had not changed. Brigadier General William G. Moore, Commander of the 834th Air Division, felt that the problem with the current MHE spare parts was a system of the greater problem.

> "Our greatest limitation in the airlift system now is the lack of MHE, that is, the equipment that the aerial ports must have to palletize loads and to load the pallets on and off the aircraft. The MHE which we have was not designed for continuous operation in the environment of dirt, sand, and mud in which we now operate the equipment at many of our isolated and dirt airstrips." (19:2)

The Lessons of Vietnam

The introduction of the 463L pallet system during the Vietnam conflict was designed to exploit the full potential of the cargo aircraft fleet. The problem with not reaching this full potential was with the MHE itself. However, this problem originated before the Vietnam conflict. First, there was no single manager of airlift activities within the DoD at that time (16:27). Second, the lack of a systems management approach to MHE development resulted in design deficiencies (16:27). For example, it took three years to fix hydraulic, electrical, and suspension problems associated with the first 40K loaders (16:27). Third, poor planning to ensure adequate delivery of spare parts caused significant problems (16:27). In some cases, no initial provisioning was provided for in the purchase agreement (16:27). Finally, aerial port terminals were not adequate. This was especially true of the aerial ports in South Vietnam. Many of these facilities lacked paved surfaces. It was common to operate MHE over dirt surfaces, which further added to the wear and tear of the K loader (16:27).

In the late 1970s, new MHE suffered from design problems. The Military Airlift Command (MAC) received 28 new Oshkosh 40K loaders in 1981 (16:28). These loaders were built from Space Corps' blueprints. Space Corps K loaders were among the original 40K loaders introduced into the Air Force inventory. However, the Oshkosh K loaders did not reflect all the Space Corps design revisions or the time compliance technical order (TCTO) changes. The new loaders were delivered to the Air Force with the same deficiencies that had already existed in the original Space Corp loaders. These deficiencies included "design problems in the hydraulic system, welded seam cracks in the hydraulic tanks caused by engine vibration, frequent cracking of radiator seams, and the crimping of brake lines that results when the bed of the K loader is lowered" (17:1)

The existing depot maintenance program, which led to the low reliability of K loaders during this period, was also a problem. The depot maintenance program revolved around two forms of repair to older, worn out equipment (16:29). The first consisted of limited repairs performed at the depot (16:29). The second form of repair was the remanufacture process where units were essentially disassembled and rebuilt from the frame up (16:29). An example of this was the Ramirez 40K loader (16:29). The Ramirez 40K was a modified version of the older Space Corps 40K loader. It was discovered that the loader bed of the Ramirez 40K loader warped when lowered to work a C-130 aircraft. As a result, the Air Force had to establish other modification programs, and for a period of years, MAC lost a partial capability to service aircraft used for tactical airlift (16:29). It is important to note that what was required then, as is required now, was for the depots to return a quality product. MHE reliability rates in Vietnam were low because of the shortage of parts, combined with the long maintenance down times at the depots. May

maintained that the modification and remanufacture of the 25K loader put the Air Force in a vulnerable position in the early 1980s (16:30). According to May, the contract for the 25K loader was awarded on 26 March 1982 (16:30). Because of delays in the contract award, some 25K loaders had degenerated to the point where they could not be repaired at base level. MAC had 29 loaders that were no good for peacetime or wartime use (16:30). The first of the 312 Air Force 25K loaders entered into this two-part maintenance program in February 1983, with the first production model scheduled for delivery in July 1983. However, remanufacture was not scheduled for completion until January 1986 (16:30).

Future MHE Design Requirements

May states Air Force leadership should design and select MHE that would continue to permit the least handling of cargo, achieve the greatest standardization of MHE types and models, and reduce the need for specialized equipment to minimum levels (16:38). Handling cargo the fewest amount of times reduces damage to both cargo and to the MHE. By standardizing MHE types, the Air Force could achieve greater versatility in working different aircraft. This would reduce the overall life cycle cost since the Air Force would have to buy, operate, and maintain fewer types of MHE. May recommends the Air Force should also only purchase MHE that consolidates the functions of separate pieces of MHE, such as a single piece of MHE that can transport the cargo to and from the warehouse, as well as interface with all types of cargo aircraft, both military and commercial (16:38). Otherwise, the proliferation of specialized MHE adds to the problem of maintaining and managing more assets. The Air Force must carefully plan the selection of future MHE to ensure the mission is met. May states that the

primary factor to consider in allocating MHE "should not be whether units use their equipment one hour per day or 12 hours a day, nor the total amount of cargo handled each day. Instead, the number of missions supported and the type of cargo handled are more important than daily hours of utilization or tonnage" (16:38). As an example, May shows that a small aerial port handling less than 250 tons of cargo per month may require a 25K loader and one 10K forklift to complete its mission (16:38). The Air Force should not exceed the capability of its existing MHE. However, this has not been the case. Some 40K loaders had been modified to service the lower cargo compartment of wide-body commercial aircraft. This was done because MAC did not have any pieces of MHE that would load the LD-3 cargo (baggage) containers on civilian aircraft. The modifications to these loaders rendered them unusable to work military cargo aircraft and limited the capability to work a mix of commercial and military aircraft.

According to May, the Air Force must design and manage its MHE system to meet the objectives of loading and unloading aircraft in minimum times (16:39). The primary factor in determining aircraft ground time is the amount of time needed to load and unload aircraft (16:39). The advent of the 436L pallet system helped the Air Force achieve a goal of reducing ground time. However, May points out that the military airlift system cannot ensure minimum ground time in a wartime environment (16:39). This problem is due to the fact that aircraft development has exceeded developments in support systems. An example of an aircraft development was the decision to use the KC-10 in a tanker and cargo role (16:40). This aircraft did not utilize the standard 108-inch rail system that other aircraft, such as the C-5 and C-141, used. The KC-10 was equipped with the same rail system used in civilian cargo planes, which is flexible and

can handle a variety of unit-load devices, such as the 463L pallet. To meet the changing needs, the Air Force procured a variety of MHE types. However, the cargo handling system lost versatility because no common core of MHE existed to service all types of cargo aircraft. May states that "the failure of the Air Force to develop a modern cargo handling system has ensured the perpetuation of an outdated methodology; it will probably still be in use at the turn of the century when it will be 40 years old" (16:40).

Study Evaluation of Current and Future Aircraft Loaders

B. L. DiFelice and George A. Fish (1986) conducted a study for Headquarters, Military Airlift Command on the importance of MHE in mobility operations. Their report, entitled Study and Evaluation of Current and Future Aircraft Loaders, examined the characteristics and system requirements for the future of MHE in the United States Air Force. This study is the foundation for developing performance requirements for future state-of-the-art MHE. The study was conducted at a time when the United States Air Force was committing itself to the development of systems that would enhance strategic airlift capabilities. Prior to the development of the C-17, the Air Force was considering new aircraft that would replace the C-130. This aircraft was called the Advanced Tactical Transporter (ATT) (7:2-6). One of the major considerations in the design of the ATT was its compatibility with the current 463L System. The development of the 463L System centered on the 463L pallet, also known as a Unit-Load Device (ULD) (7:2-6). Because the 463L pallet had to be compatible with various cargo aircraft, all future developments of MHE hinged on the transport of the 463L pallet. The 463L pallet is also compatible with some commercial cargo carriers. Therefore, the MHE system had to also accommodate commercial carriers. At the time of the DiFelice and

Fish study, not all MHE was commercial aircraft compatible. However, DiFelice and Fish study demonstrated that future MHE requirements had to be compatible with both the 463L System and commercial cargo capabilities (7:2-7).

The Small Cargo Loader Study

Tim Ringler, of the Nichols Research Corporation, and Lieutenant Wid Hall (1994), conducted an extensive research project concerning the need for improved MHE. Ringler and Hall published a report entitled Small Cargo Loader Study. In their study, they state that AMC must continue to modernize its MHE fleet if it is to continue its mission of meeting rapid response to a wide spectrum of contingencies (22:1-1). According to Ringler and Hall, AMC is still confronted with major challenges that will tax the command's ability to place the right cargo at the right place (22:1-1). To meet these challenges, AMC must continue to modernize the MHE fleet. Ringler and Hall state,

> "The fleet must be healthy; not worn out. The fleet must be able to work all organic and commercial aircraft; not simply narrow-body aircraft. The fleet must be flexible to meet today's changing missions. The fleet must consist of a balanced mix of large and small loaders, yet gain efficiencies through a common core fleet." (22:2-1)

Deficiencies of Current Materiel Handling Equipment

According to Ringler and Hall, there are three major deficiencies with the current MHE (22:1-1). The first major deficiency is that AMC is currently relying on an outdated fleet that requires considerable upgrading (22:1-1). AMC is experiencing reliability rates for the 25K, 40K, and WBEL that are much worse than that anticipated by the new Tunner 60K loader (22:1-1). In 1984, AMC began work toward replacing the 40L loader (22:2-1). The resulting Tunner 60K loader entered the inventory in 1997.

Because the 60K contains state of the art technology, AMC anticipated a 100-hour mean-time-between-failure (MTBF) and a 400-hour mean-time-between-critical- failure (MTBCF) (22:2-2). According to Major Keith Fletcher, to date the Tunner 60K does not see rates at this level. More realistically, Tunner 60K loaders experience rates in the 10-30 hour range (10:1). In 1994, AMC was experiencing reliability rates for the 25K, 40K, and WBEL that were much worse than anticipated by the new Tunner 60K Loader (22:2-2).

In March 1993, Headquarters AMC Transportation Directorate recommended cancellation of any 25K TAC loader overhaul programs, opting instead for these loaders to be processed for disposition as they meet or exceed disposition criteria (22:2-2). In addition, heavy use due to increasing air mobility taskings led to structural metal fatigue and frame cracks in nearly 57 percent of the 40K loaders and 79 percent of the 25K loaders (22:2-2). The only reason the fleet operated the way it did was because an aggressive maintenance program kept the loaders in commission. In a study of seven bases, AMC found that approximately 1,700 man-hours and nearly $100,000 were spent at these locations alone to maintain 115 of the 1,000 + loaders in use (22:2-2).

The second major deficiency is the lack of flexibility/efficiency of AMC's current MHE to service all aircraft, both organic and commercial (22:2-2). Table 2 is a summary of the types of aircraft that AMC K loaders can service. The TAC loader is the most restrictive. It will neither load commercial narrow nor wide-bodied aircraft. Additionally, C-5s must be in the kneeling configuration to be serviced by the TAC loader. Both the 25K and 40K loaders cannot reach the 15 to 18 feet required to service commercial wide-bodied aircraft.

Table 2. Inability to Reach Wide-Body Aircraft

Type Loader	Military Organic	CRAF Narrow Body	KC-10/CRAF Wide Body
40K Loader	Yes	Yes	No
25K Loader	Yes	Yes	No
25K TAC Loader	Yes*	No	No
	*C5 only when in kneeling configuration		

Source: Tim Ringler and Wid Hall. Small Cargo Loader Study. Nichols Research Corporation, Huntsville, AL. October 1994. P. 2-3.

Commercial wide-bodied aircraft are playing a bigger part in the fleet mix. For example, in 1975 there were 253 narrow-bodied aircraft and 36 wide-bodied aircraft participating in CRAF (22:2-2). As of 1994, the aircraft mix consisted of 106 narrow-bodied aircraft and 148 wide-bodied aircraft (22:2-2). Changes in global and regional strategy have also affected the requirements placed on MHE. A lack of sufficient numbers of wide-bodied loaders will affect the use of global reach laydown packages and the ability to simultaneously support two major theater wars (MTW) as well as a humanitarian operation (22:2-3). As the 25K loader fleet continues to age, it will become increasingly more difficult to support theater deployability. This is because the 25K loaders are the Air Force's main K loaders at most of the locations around the world. The 25K loaders were assigned to 222 locations globally, while 40K loaders were assigned to 81 installations (22:2-3).

The third major deficiency is the lack of commonality among AMC loaders (22:2-4). The current MHE fleet consists of loaders manufactured by 14 different companies (22:2-2). Greater efficiency from the MHE fleet is needed, with lower maintenance costs. If attainable, reducing the number of AMC loaders to two loaders (one small loader and one larger one) is needed. The new Tunner 60K loader provides

efficiency for locations that work high volumes of cargo and strategic airframes. A new, smaller, theater deployable loader, which supports rapid deployability for contingency and humanitarian operations, as well as peacetime missions at more austere locations, would satisfy the remainder of AMC's MHE requirements. Together, the new Tunner 60K loader and a new smaller 25K loader could replace the aging MHE fleet, reduce maintenance costs, service all aircraft, and achieve a higher commonality and efficiencies (22:2-4). The ability of a new 25K loader to reach the wide-body aircraft provides the single most important operational benefit attainable by any of the performance improvements to the old 25K loader. Besides the added flexibility of being able to service wide-body aircraft, the deployment of the WBEL to sites requiring the servicing of wide body aircraft is no longer needed (22:5-7). Typically, two C-130s are required to deploy the required MHE to a wide-body aircraft site. Currently, they transport a WBEL, a forklift to unload the WBEL, and a 25K loader to feed pallets to the WBEL (22:5-7). Often two WBELs are deployed to a given site because of the reliability problem experienced with the WBELs. Having a self-propelled 25K loader with an 18-foot reach will require only one sortie to deploy to the site. This capability will allow additional space on the C-130 for more cargo. The cost savings resulting from the reduction in the number of sorties required to deploy the MHE for wide-bodied aircraft appear large enough to offset the additional costs of incorporating an 18-foot reach into a new 25K loader design (22:5-7).

According to Ringler and Hall, in 1994 the Air Force was authorized 1,365 K loaders (22:5-1). Of this number, approximately 79 percent were assigned. Wide variations in the capabilities of the K loaders existed at that time. Table 3 illustrates the

number of K loaders authorized and assigned. These authorizations are based on Air Force-wide authorizations.

Table 3. Number of Loaders Authorized vs. Assigned

Type Loader	Authorized	Assigned	Percentage
40K Loader	380	283	74
25K Loader	786	650	82
WBEL	199	131	66

Source: Tim Ringler and Wid Hall. Small Cargo Loader Study. Nichols Research Corporation, Huntsville, AL. October 1994. P. 5-1.

Table 4 illustrates the capability and transportability of loaders. It is important to note that although the 40K loader can be transported on both the C-141 and the C-5, an extensive amount of shoring is required.

Table 4. Capability/Transportability of Loaders

	Capability				Transportability		
	No of Pallets	Wide Body Military	Narrow Body Commercial	Wide Body Commercial	C-130	C-141	C-5
40K Loader	5	No	Yes	No	No	Yes	Yes
25K Loader	3	No	Yes	No	Yes	Yes	Yes
WBEL	1-3	Yes	N/A	Yes	Yes*	Yes*	Yes
*Of the 8 different types of WBELS, only 2 are designed for aircraft transport.							

Source: Tim Ringler and Wid Hall. Small Cargo Loader Study. Nichols Research Corporation, Huntsville, AL. October 1994. P. 5-2.

Required Loader Performance

The performance requirements for the development of a new loader must satisfy many different demands. Transportability on C-130 aircraft is one of the most important criteria (22:5-6). The large number of C-130 aircraft in the inventory, coupled with its mission flexibility, make the C-130 a vital element of air mobility. A 25K loader with the ability to be air transportable aboard a C-130 would enhance AMC's flexibility in

deploying MHE. The loader must be designed to collapse to a size that enables it to fit on a C-130 and on a flatbed truck. Also, the ability of the loader to provide its own power for loading itself on the C-130 eliminates the need for other equipment and saves manpower (22:5-6). Designing a loader that can fit on the C-130 is truly a challenge because the loader must fulfill its most important operational requirement, which is to have the ability to reach the 18-foot deck of commercial wide-bodied aircraft. Additionally, the loader must be able to carry 25,000 pounds of cargo. Finally, one area of improvement for a new loader is to reduce the amount of time required to assemble and disassemble the loader for transporting (22:5-7). Recent loader designs have made headway in the area without major cost to other performance penalties. These are achieved by simply implementing good design practices.

The Impact of Performance Requirements on Loader Designs

The Aeronautical Systems Center Deputy for Development and Planning, as well as representatives from Nichols Research Center met with designers of loaders at Southwest Mobile Systems Corporation in St. Louis, Missouri, and at Teledyne Brown in Huntsville, Alabama, to discuss the design of the loaders and determine performance requirements (22:5-7). According to Ringler and Hall, a general consensus was established which determined the four major performance requirements that would have the biggest impact on the design of the new 25K loader (22:5-7). These performance requirements include: 1) the reach of the loader, especially extending it to 18 feet; 2) the lift capacity of the loader; 3) the static and dynamic design safety factors; and 4) the number of pallets (22:5-7). Extending the 25K loader from 13 feet to 18 feet would substantially increase the weight of the loader. Therefore, more material is required in

the extension structure. Additionally, the increased weight of the loader and the complexity of the design will increase the acquisition cost of the loader. However, Ringler and Hall state the ability to reach the wide-body aircraft provides the single most important operational benefit attainable by any of the performance improvements to the 25K loader (22:5-7).

Next Generation Small Cargo Loader Study

Major Larry Stephens (1996), in his study entitled Next Generation Small Cargo Loader Study, states that the NGSL is envisioned as an updated replacement for two types of MHE, the 25K loader and the WBEL (24:2). According to Stephens, "AMC has stated an initial NGSL requirement of 300 loaders based, in part, on the current fleet profile and the number of K loaders and wide body loaders needed to satisfy daily operations and wartime requirements" (24:2). Stephens' study reviews formalized, published wide body MHE and support requirements. These requirements pertain to the DoD's ability to support a forward projection philosophy. According to Stephens' findings, the Air Force had 84 percent of its total worldwide 25K loader requirements filled (24:2). WBEL shortfalls were worse, with a 44 percent fill rate (24:2). AMC suffered a higher shortfall ratio since its fleet comprised the largest contribution to the Air Force total. In 1996, its 25K loader requirement was at 33 percent of the requirement, while WBELs meet only 27 percent of the requirement (24:3). Conversely, there were apparent large overages of 25K loaders and WBELS assigned to other commands, such as the United States Air Forces in Europe (USAFE), United States Central Command Air Forces (CENTAF), and the United States Pacific Air Forces (PACAF) (24:3). AMC still has MHE joint use agreements with the other commands, so assets assigned to the other

commands for daily base operations that support peacetime or wartime requirements, by agreement, are to be made available to AMC for use in supporting strategic airlift operations.

Age of MHE

Stephens demonstrates that the MHE fleet has reached or exceeded is programmed life expectancy. According to Stephens, of its entire fleet of 656 25K loaders worldwide, the Air Force had a total of 449 vehicles (68 percent) which reached or exceeded their programmed life expectancy (24:4). These loaders were originally manufactured during the mid-1960s. After reaching or exceeding their life expectancy in the 1980s, these loaders were re-manufactured and re-introduced into the fleet (24:4). The loaders have once again exceeded their extended life cycles. Many loaders are showing signs of weakening and fatigue. Also, of the 115 total 25K loaders assigned at the five AMC CONUS study sites (Charleston AFB, SC; Dover AFB, DE; McChord AFB, WA; McGuire AFB, NJ; Travis AFB, CA), 58 percent were remanufactured loaders with an average operating time in 1,269 hours per vehicle (24:4). Over half of AMC's 25K loader capability, throughout the CONUS strategic aerial ports, had actually twice exceeded its life expectancy with over 20 years in service (24:4). The Air Force WBEL fleet of 99 vehicles also exceeded their operational life expectancy, based on their original entry into service (24:4). Many completed depot rebuild programs, which extended their life expectancies until 1995, and in some cases through to 2000. However, high taskings and unequal usage combined to create a great disparity between the individual loaders at the five CONUS study sites. Although the WBELs had an overall operating time average of 1,080 hours, there were vehicles with very low usage, showing

below 200 hours, while other show over 3,000 hours (24:4). Because WBELs provide wide-body aircraft support worldwide, they must be disassembled for movement from their home station, reassembled at the deployment site, and disassembled again for the return trip. Each mobilization causes accelerated wear-and-tear, including the weakening of the vehicle's frames, all of which are original equipment despite depot rebuilds. The WBEL fleet was heavily used, although its use was not evenly distributed among assignments.

According to Stephens, in 1996 the Air Force 25K loader fleet was comprised of 305 Emerson loaders, out of a fleet of 656 25K loaders worldwide (24:20). These loaders were delivered during the mid-1960s. By the early 1980s, these loaders reached their life expectancy and were being re-manufactured by Emerson Electronics (24:21). The re-manufacturing included engines, cables, and electrical equipment, which was expected to increase the life expectancy by another 10 years (24:21). At the time, these loaders met their second life expectancy. Table 5 describes a list of re-manufactured loaders.

Table 5. Re-manufactured 25K Loaders

Site	Total Number 25K Loaders	Total Number Emerson Loaders	Percent	Average Clock Time Per Loader
Charleston AFB	24	13	54%	1,653 hours
Dover AFB	20	9	45%	1,279 hours
McChord AFB	24	15	63%	1,087 hours
McGuire AFB	28	19	68%	1,101 hours
Travis AFB	19	11	58%	1,344 hours
TOTALS	115	67	58%	1,269 hours

Source: Larry Stephens. Next Generation small cargo Loader Study. Mobility Concepts Agency, Fort Monroe, Virginia. August 1996. P. 21.

It is important to note that even though these loaders were re-manufactured, their frames were not overhauled. Units in the field increasingly reported cases of frame cracks

occurring due to the extended metal fatigue. The re-manufactured K loaders comprised a significant portion of Stephen's study.

Stephens points out that AMC realized the importance of developing a strategy to combat the problem of aging MHE. According to Stephens, the first measure AMC has considered was how AMC envisions filling the K loader shortfalls by looking at long-term versus temporary fixes (24:38). Programs such as the K loader depot repair program and the 25K loader high reach extension modification are short-term in nature and do not solve the long-term problem. The depot repair program may extend K loader life cycles on paper, but the original frames remain as part of the vehicles and will eventually limit the loader's use. The 25K loader high-reach modification program gave AMC some additional wide body capability. However, it will not utilize the updated technology being used by the Tunner 60K loader (24:38). Also, modified high reach 25K loaders are not as flexible in meeting AMC's deployment mission as AMC would like. Second, AMC has anticipated the eventual degradation of the 25K loader fleet due to age and high use (24:39). Stephens states that there is no easy method of capturing the entire cost of maintaining the 25K loader fleet without improved data collection and tracking methods (24:39). Some of the factors, which must be captured but are not easily made available, are the costs involved with delaying missions due to MHE positioning and breakage, transporting MHE personnel and parts after vehicles break on site, the costs associated with manufacturing new parts no longer made, and the increased manpower to maintain and operate the equipment. Third, AMC realized that improved MHE capability provided maximum flexibility and response to the theater Commander-in-Chief (CINC) during the deployment and sustainment of airlift operations (24:39). As the DoD

continues to evolve into a CONUS-based, power projection force, significant amounts of strategic lift will be required. Forces must be able to deploy quickly. Once in theater, forces will require responsive airlift capability to react to the changing operational environment. With current initiatives, such and the DoD's development of Intransit Visibility (ITV), it will become possible for theater commanders to have real-time capability to access cargo and passenger movements, thus enabling them to make adjustments based on existing threats, or the damage/saturation of aerial ports of debarkation (APODs). Theater CINCs will have the capability to redirect missions already enroute, including CRAF wide body aircraft and Air Force KC-10s. The NGSL program will directly support this concept, and will ensure a flexible, robust wide-body support capability for theater airlift operations. Finally, AMC realized that the development of the NGSL will save on strategic airlift, thus releasing those resources back to the supported CINC by not having to deploy and continuously reposition 25K loaders and WBELs (24:39). For those locations where the NGSL is in place, the need for WBELS will not be necessary. This will eliminate an additional competition for critical theater transportation assets. This also cuts the pre-deployment, on-station, and post-deployment time required for airlift support teams by decreasing, and eventually eliminating the need to prepare WBELs for transport.

III. Methodology

Overview

The decision to begin development of the NGSL was predicated on several factors. The current fleet of 25K loaders, 40K loaders, and WBELS has exceeded their life expectancy. The technology associated with the 25K loader, 40K loader, and the WBEL has not kept pace with current mobility requirements. A combination of a WBEL and either a 25K loader or a 40K loader is needed to upload commercial cargo aircraft, or KC-10 aircraft, if a Tunner 60K loader is not available. Air transportation of MHE is also a problem. The combination of air transporting both the 25K loader and WBEL is cumbersome. Cargo-loading operations at locations that lack on-station commercial cargo-loading MHE require the transportation of both the 25K loader and the WBEL. Once on station, the 25K loaders and the WBELS must be operated and maintained by a contingent of personnel. The development of the technology for a small loader, which can interface with both military and commercial cargo aircraft, as well as having the capability to be air transportable on all U.S. Air Force cargo aircraft, was also a driving force behind the development on the NGSL.

Methodology

The approach to analyzing the benefits of the NGSL is to examine how the NGSL will contribute to the overall reduction of the mobility footprint and MHE operating cost. The benefits of the reduction of the mobility footprint will be described in the following areas: 1) a reduction in manpower to operate and maintain the NGSL; 2) reduced operating cost of the NGSL compared to the current cost of maintaining outdated MHE; 3) reduced ground times in cargo-loading operations; 4) increased aircraft capacity as the

NGSL frees up more airlift capacity; 5) and overall reduction of vehicle authorizations by replacing the 25K loader and the WBEL with the NGSL. Data needed to compare these benefits will come from the 436th Aerial Port Squadron, Dover Air Force Base, Delaware. Dover Air Force Base was chosen for this research because it maintains the largest Air Force aerial port facility on the Eastern Coast of the United States. Additionally, Dover will be the first base to receive the NGSL into its fleet of MHE.

Reduction in Manpower

The first area of examination in the reduction of the mobility footprint is in manpower. "Air Force Instruction 38-201, Determining Manpower Requirements" (1999) defines manpower as "a critical resource that supports an approved program" (1:42). Examining how personnel are utilized in a typical 24-hour work day at Dover Air Force Base will be done through an analysis of the 436th Aerial Port Squadron's Ramp Section personnel MHE qualification list. The Ramp Section of the aerial port is responsible for the uploading and downloading of all (commercial and military) cargo aircraft that originate or transit through Dover Air Force Base. An interview with the superintendent will explain how personnel, who are authorized and assigned to the Ramp Section, are assigned tasks associated with cargo-loading operations. The interview will also explain how the personnel perform the cargo-loading/unloading operations with the 25K loader and the WBEL as the primary loaders. The information will include a listing of personnel, by Air Force Specialty Code (AFSC), which will indicate on which pieces of MHE the personnel are qualified. This information is contained in Appendix B. The section superintendent uses this information to determine the optimum number of crews, as well as the optimum number of crewmembers, that will be needed to perform the daily

cargo-loading mission. This information will be used as a baseline to determine the reduction in personnel when the NGSL is employed. The analysis used for the research will be based on the 24-hour cargo operations of the aerial port, and will examine how personnel loaded or unloaded (palletized and rolling stock) cargo on the types of aircraft serviced.

Another area of reduction in manpower pertains to the amount of personnel needed to maintain MHE. The 436th Transportation Squadron Maintenance Control and Analysis Flight will provide the data concerning the manpower needed to maintain the fleet of MHE at Dover Air Force Base. The information will be gleaned from the maintenance records of the 25K loader and WBEL fleet at Dover Air Force Base from August of 1996 to August of 1997. This information will contain the maintenance actions performed on all the 25K loaders and WBELs assigned to the 436th Aerial Port Squadron, and will be broken down by individual vehicle registration number, type of work performed on the vehicle, and amount of time required maintaining the item (Appendix C). The Maintenance Control and Analysis Flight will access the On-line Vehicle Information Management System (OLVIMS) to obtain the historical data for this analysis. The focus of these reports will be on the number of times an individual loader went into repair for a critical failure item. Scheduled maintenance actions will be included because these actions, which include period lube, oil, and filter (LOF) changes, are typical of all vehicles. The reports will primarily examine how often an individual loader entered repair by examining the loader's maintenance record. The information compiled from the Dover records will be examined to evaluate estimated performance objectives for the NGSL.

Reduction in Operating Costs

Determining if there will be a reduction in operating cost for the NGSL, compared to the 25K loader and the WBEL, will be done by two mehods. The first method is to determine the overall value of what the Air Force pays personnel who fix MHE. The information used to determine the number of mechanics needed to fix MHE at Dover again comes from the 436th Transportation Squadron Maintenance Control and Analysis Flight. The cost information will be applied to the number of technicians needed to maintain the 25K loader and WBEL Fleet at Dover Air Force Base. The costs associated with a mechanic's salary will be applied to the number of personnel needed to maintain the NGSL fleet.

The second method of determining a reduction in overall operating costs is to examine the maintenance cost of the 25K loader and WBEL fleet at Dover Air Force Base. Information on the maintenance cost will also come from the 436th Transportation Squadron Maintenance Control and Analysis Flight. Maintenance records, for each 25K loader and WBEL, will be analyzed, beginning with the records from August of 1996 and concluding with the records of August 1997. Based on the information already obtained from the maintenance records, an estimate of the average cost, per vehicle, will be derived. The analysis of the estimates will take into account the present value of money, when comparing the estimated cost of maintenance for the NGSL.

Reduced Cargo Upload Times

With the NGSL combining the capabilities of both the 25K loader and the WBEL, it is assumed that the NGSL will produce a reduction in cargo upload and times. Captain Todd Dyer (2000), from the Air Force Logistics Management Agency (AFLMA),

conducted a study entitled "Materiel Handling Equipment (MHE) Capabilities Study" in which he measured the time needed for a 25K loader to deliver cargo from the aerial port warehouse to the aircraft. Additionally, he measured how long it took the load crew to upload cargo. Dyer's results provide the baseline information for a comparison between the performance of the 25K loader and the performance of the NGSL.

The information used in Dyer's study will be used to demonstrate how the loading capabilities of the NGSL differ from the loading capabilities of the 25K loader and the WBEL. To accomplish this, the analysis will examine the results obtained by the 25K loader, with the WBEL combined in the uploading process. Information on the amount of time the WBEL requires to load cargo from the K loader to the aircraft will come from the 436 Aerial Port Squadron Ramp Section. The enhanced capabilities of the NGSL, such as the powered roller system, reduction in personnel needed on the flight line, and the elimination of the WBEL, will be discussed in the analysis of the capabilities of the NGSL. The information obtained from the MHE capabilities study will be the baseline for the analysis of the NGSL's loading capabilities.

Aircraft Capacity

For the purpose of this research, aircraft capacity is defined as the amount of space a cargo aircraft has available for the movement of cargo. Deployment of MHE, in support of contingency operations or mobility exercises, is critical to cargo loading/downloading operations at forward bases. However, the deployment of airlifted cargo is limited by the amount of cargo an aircraft can transport. Prior to the advent of the Tunner 60K loader in 1996, 25K loaders, 40K loaders, and WBELs were deployed on C-5, C-141, or C-17 cargo aircraft. The Tunner 60K loader has been a great

improvement to the efficiency of cargo operations worldwide. However, its size is a tremendous challenge in terms of airlift deployment. The Tunner 60K can be transported on C-5, C-17, and C-141 aircraft, but cannot be transported on C-130 aircraft. Table 6 demonstrates the airlift capabilities of the Air Force cargo aircraft. KC-10 aircraft are not included in the table because this aircraft does not have the capability to transport any type of MHE.

Table 6. United States Air Force Cargo Aircraft Capability

Aircraft	Pallet Positions	Maximum Pallet Weight	Maximum Cargo Weight
C-130	6	10,000 lbs*	52,664 lbs
C-141	13	10,000 lbs**	127,5000 lbs
C-17	18	10,000 lbs	180,000 lbs
C-5	36	10,000 lbs***	355,000 lbs

*Pallet position 5 restricted to 8,000 lbs; Pallet position 6 restricted to 4,664 lbs.
** Pallet position 13 restricted to 7,500 lbs.
***Pallet positions 35 and 36 restricted to 7,500 lbs. Each.

Source: 436 Aerial Port Squadron Load Planning Section, Dover Air Force Base, DE

Analysis of aircraft capacity will be conducted by examining how much aircraft space a 25K loader and a WBEL utilize on the various cargo aircraft. This information will be compared to the amount of space the NGSL utilizes on cargo aircraft. The difference in capacity will then be translated into the amount of cargo that can be loaded on the aircraft. The information gathered on the amount of cargo capacity will come from historical data from Operation ALLIED FORCE. The information consists of cargo movement on C-5, C-17, 747, and DC-8 cargo aircraft, deployed from Dover Air Force Base from 3 April 1998 to 17 May 1998. Analysis of the cargo data will be used to demonstrate how the cargo aircraft, that deployed from Dover Air Force Base, utilized aircraft capacity. For the purpose of this analysis, it is assumed also that only 25K loaders and WBELs were deployed. The assumption is that since commercial aircraft

were deployed in support of Operation ALLIED FORCE, WBELs were needed to download the cargo upon arrival, then upload the cargo after the completion of the operation. This analysis assumes the support of Operation ALLIED FORCE included six 25K loaders and three Cochran WBELs. The amount of cargo space the 25K loader uses is equal to the space the NGSL uses. Additionally, the pallet capabilities of the 25K loader and the NGSL remain the same; therefore, the number of NGSLs will remain equal to the number of 25K loaders deployed. However, deployment of 25K loaders requires a complement of WBELS. The analysis will demonstrate the difference between deploying with a combination of 25K loaders and WBELS versus deploying with only the NGSL.

Reduction In Vehicle Authorizations

In April of 1998, Scott Air Force Base, Illinois, hosted the 1998 Worldwide Materiel Handling Equipment Conference. The purpose of the conference was to determine how MHE authorizations would affect those bases that had requirements for MHE (27:1-15). The results of the conference do not include any authorizations for the NGSL because the NGSL was still in the planning/development phases and the final contract for production had not been awarded. In March of 2000, the Worldwide Materiel Handling Equipment Conference reconvened again at Scott Air Force Base, Illinois. During this conference, the NGSL was included in the planning for vehicle authorizations (28:1-16). An analysis of the results of both conferences will demonstrate any overall changes in authorizations of MHE. An explanation of how to interpret the data from both conferences will be included in Chapter IV, Data Analysis.

IV. Data Analysis

Overview

The purpose of this chapter is to analyze the reduction in the mobility footprint, resulting from deployment of the NGSL. For the purpose of this analysis, the mobility footprint is defined as the amount of resources required to sustain mobility operations. The demonstration of the reduction of personnel and equipment, during peacetime operations, serves to demonstrate a possible reduction in assets during contingency operations. This analysis will examine five areas of reduction in the mobility footprint. The first area is in the reduction of manpower required to operate and maintain the NGSL. A reduction in manpower advocates the advancement in technology used in the NGSL. The second area of analysis is in reduced overall operating cost. This analysis will examine the estimated overall savings experienced with a reduction in manpower and maintenance actions. The third area of analysis is in reduced cargo loading times. Application of the NGSL will demonstrate how it enhances cargo-loading operations by increasing loading efficiency while decreasing loading times. The fourth area of analysis is in cargo aircraft capacity. The analysis will demonstrate how the NGSL will potentially save aircraft cargo capacity when it is deployed. The fifth area of analysis deals with how the NGSL will affect overall vehicle authorizations. Analysis of vehicle authorizations will demonstrate that the NGSL not only replaces the 25K loader, in terms of its ability, but also eliminates the WBEL authorizations, altogether.

Reduction in Manpower

Manpower authorizations in the 436th Aerial Port Squadron are based on cargo tonnage workload, while manpower authorizations in the 436th Transportation Squadron

are based on vehicle equivalents, that is, the number of vehicles needed to complete the mission of the squadron. The Ramp Section of the 436th Aerial Port Squadron consists of 69 military personnel and 8 civilian personnel. Table 7 presents a breakdown of personnel based on AFSC and qualification on the various pieces of MHE.

Table 7. Dover Air Force Base MHE Qualification Breakdown, January 2001

AFSC	NUMBER	25K QUAL	40K QUAL	WBEL QUAL	60K QUAL
2T231	13	5	7	0	4
2T251	48	47	47	12	43
2T271	8	7	7	2	10
Civilian	8	6	6	6	4
Total	**77**	**65**	**67**	**20**	**61**

Source: 436 APS Ramp Section. AFSC 2T2XX =Air Transportation Specialist

Personnel listed as 2T231 are in the initial Apprenticeship of their career development. Personnel listed as 2T251 are in the Journeyman phase of their career development, and personnel listed as 2T271 are in the fully trained Craftsman phase of career development. According to MSgt Terry Arnann (2000), the 436th Aerial Port Squadron Ramp Section Superintendent, Dover processes, at the maximum, six aircraft in a 24-hour period (2). This number of aircraft is typical of a daily, peacetime tempo. These aircraft typically include two C-5 originators, two C-17 intransit aircraft, one B-747, and an occasional intransit C-141. The workload at Dover is divided into three shifts: a) dayshift has 26 personnel; b) swing shift has 29 personnel; c) night shift has 22 personnel. Table 8 lists Dover's Maximum on Ground (MOG) for the various military aircraft. The superintendent uses the MOG information, as well as the MHE qualification information, to determine the proper number of crews to place on the ramp to perform the cargo loading operation.

Table 8. Dover MOG Capability

Type MOG	C-130	C-141	C-17	C-5
Contingency MOG	10	8	10	8
Max. Theoretical MOG	82	42	72	26
Working MOG	7	5	5	2

Source: 436 Airlift Wing Base Operations, Dover Air Force Base

Based on the typical peacetime airflow and the working MOG, each shift works two aircraft. It is the responsibility of the shift supervisor to ensure each shift has the proper number of ramp crews to work the aircraft. To work two aircraft, assuming the only MHE available are the 25K loaders and the WBELS, would require two crews of nine personnel. Five personnel would drive four 25K loaders, two persons would drive the WBEL, one person would serve as a spotter, directing the MHE into position, and the senior ranking person would serve as the crew chief. Depending on the condition of the WBEL, two personnel may be required to operate the WBEL. One person would drive the WBEL and the other would ensure the WBEL meets the clearance restrictions when it reaches the B-747. The rule of thumb for WBEL operations is to keep two drivers available to operate the loader. The Cochran WBEL, which is used at Dover, can upload two pallets at a time. When the loader is not in use, it is stored at the aerial port with the other MHE. Two operators drive the WBEL from the port to the aircraft, when it is put into use. One person drives the WBEL and the other person ensures the WBEL safely meets the clearance restrictions for the aircraft. A third person remains on the ground and spots the WBEL into position against the aircraft. The ground spotter coordinates with the clearance spotter to safely position the WBEL near the aircraft.

Once the WBEL is in place, a 25K loader, with cargo, positions itself against the aircraft. The Cochran WBEL has the capability to load two pallets at a time.

Additionally, the WBEL cannot transport cargo on its platform. It must travel without any prepositioned pallets on the platform. After the WBEL is positioned next to the aircraft, and is ready for cargo operations, the 25K loader approaches the WBEL, with its platform at the same level as the WBEL, and cargo is transferred from the 25K loader to the WBEL. The 25K loader does not have mechanized roller system on its platform, as does the Tunner 60K loader. Therefore, the cargo must be pushed from the 25K loader to the WBEL. If a pallet weighs the maximum pallet weight allowance, two personnel must push the pallet onto the WBEL. Once two pallets are on the WBEL, the pallets are lifted up to the aircraft cargo floor. While the pallets are loaded from the WBEL to the aircraft, a second 25K loader positions itself behind the first 25K loader, and uses the first loader as a bridge to offload more pallets. The WBEL operator lowers the platform to collect two more pallets. Once the two pallets are loaded on the aircraft, the two remaining pallets from the second 25K loader are pushed onto the first 25K loader. The second 25K loader will pull away from the first loader, return to the port for more cargo, and the third 25K loader will position itself against the first 25K loader to repeat the process until all the aircraft's pre load-planned pallets are aboard.

Utilization of the NGSL will eliminate the need for the WBEL altogether. Pallet capabilities of the NGSL are the same as the 25K loader. However, the platform of the NGSL utilizes a mechanized roller system, which eliminates the need for the two pallet pushers. When the NGSL approaches the aircraft, the ground spotter can position the NGSL without the concern for meeting the clearance restrictions. The NGSL transports cargo in its lowest configuration, eliminating the concern for clearance objects, such as low hanging coverings or electrical wires. When the NGSL is in place, the NGSL

operator raises the platform to the height of the aircraft floor. The three pallets are pushed onto the aircraft by the mechanized roller system. Once the pallets are on board, the NGSL lowers its platform, is spotted away from the aircraft, and returns to the port to pick up three more pallets. The next NGSL is then positioned near the aircraft, and the entire cargo loading process begins again until all preload-planned pallets are aboard. The B-747 has a 42-pallet capability. To fill the aircraft requires 14 NGSL equivalents. The crew of nine personnel can be reduced to a crew of six personnel, which is a thirty-three percent reduction in the number of personnel needed to upload the B-747.

A second area of manpower reductions is in vehicle maintenance. Vehicle maintenance records, from August of 1996 to August of 1997, show that there were a total of 186 maintenance actions on all the 25K loaders and WBELS combined. Table 9 shows the breakdown of the number of maintenance actions performed on each 25K loader and WBEL loader. When a vehicle enters the maintenance shop, it is typically out of commission for at least a day. Maintenance actions range from scheduled maintenance checks to major engine repair. Based on the type of maintenance action required, the average amount of time a either a 25K loader or a WBEL is out of commission is approximately two days. Assuming one day equates to eight hours of labor, the average number of manhours required for maintenance on any 25K loader or WBEL is 16 hours. Table 10 represents the estimated amount of manhours needed to perform maintenance on each piece of MHE.

Table 9. Maintenance Actions, Dover Air Force Base, August 1996-August 1997

Registration Number	Type Vehicle	Number Maintenance Actions
84E00414	25K Loader	22
85E00021	25K Loader	10
85E00107	25K Loader	5
85E 00765	25K Loader	10
85E00805	25K Loader	15
85E00807	25K Loader	12
85E00822	25K Loader	18
92E00081	25K Loader	30
92E00082	25K Loader	7
93E00113	25K Loader	1
93E00145	25K Loader	19
87E00001	25K Loader	12
82E00145	25K Loader	4
82E00145	Cochran WBEL	7
82E00160	Cochran WBEL	7
82E00151	Cochran WBEL	7
	Total Maintenance Actions	**186**

Source: 436 Transportation Squadron Maintenance Control and Analysis Flight, Dover Air Force Base

Table 10. Estimated Maintenance Manhours, Dover, August 1996-August 1997

Type Vehicle	Number Maintenance Actions	Maintenance Manhours
25K Loader	165	2,640 manhours
Cochran WBEL	21	336 manhours
Total	**186**	**2,976 manhours**

Source: 436 Transportation Squadron Maintenance Control and Analysis Flight, Dover Air Force Base.

The elimination of the WBEL altogether would equate to a possible average savings of 336 manhours of maintenance per year. Based on this estimate, a reduction of

maintenance personnel could be realized by at least two mechanic authorizations, or the savings in manpower could equate to more mechanics available for other maintenance tasks, thus increasing overall vehicle in-commission rates.

Reduced Operating Cost

An area of potential savings in operating costs to the Air Force would be in the reduction of personnel required to maintain the NGSL. The military pays its members based on rank, not job skill level. It is possible for a military member to achieve a skill level that is greater than the commensurate grade. However, the individual still receives pay at the posted grade. The member does not receive additional pay for a higher skill level. Table 11 gives a breakdown of the enlisted basic pay and entitlements.

Table 11. Enlisted Compensation Data (per month)

Enlisted Grade	Base Pay	Entitlements*	Total
E-1 < 4 yrs	$964.80	$469.20	$1,434.00
E-1 > 4 yrs	$1,042.80	$489.00	$1,531.80
E-2 > 4 yrs	$1,169.10	$516.60	$1,685.70
E-3 > 6 yrs	$1,385.40	$576.30	$1,961.70
E-4 >10 yrs	$1,653.00	$582.30	$2,235.30
E-5 > 10 yrs	$1,930.50	$630.90	$2,561.40
E-6 > 12 yrs	$2,196.90	$662.10	$2,859.00
E-7 > 14 yrs	$2,529.60	$704.40	$3,234.00
E-8 and E-9 counted as management, not actual working mechanics. *Includes Basic Allowance for Housing (BAH) at the single full rate and Basic Allowance for Subsistence (BAS) for rations in-kind not available.			

Source: Defense Accounting and Finance Analysis Branch, Denver, Colorado. January 2001

Dover's 436th Transportation Squadron manpower authorizations are based on vehicle equivalents. The elimination of the four WBEL authorizations would equate to the loss of approximately two personnel authorizations. The 2000 Worldwide MHE

Conference Requirements Validation shows that Dover's total amount of cargo MHE was determined to be 12 Tunner 60K loaders, 12 NGSLs, 3 25K loaders, and the authorizations for both the 40K loader and WBEL were eliminated. According to Technical Sergeant Tom Hardin, 436th Transportation Squadron 436L Maintenance Shop Superintendent, the most likely authorizations that would be eliminated would be in at the Journeyman level (5-level) of career development (12). These personnel range in rank from Airman First Class (E-3) to Staff Sergeants (E-5). In the case of the Dover's 463L Maintenance Shop, two manpower authorizations, at the 5-level, would be lost. This equates to the possible loss of two E-3s (12). Major Crupe (2001), the AMC MHE Requirements Manager, estimates that with the elimination of the 59 WBEL authorizations, approximately 15 manpower authorizations, worldwide, would be lost (5:1). Assuming these authorizations are at the 3-level, a potential savings to the Air Force would be equal to $353,106 per year ($1,961.70/month x 12 months x 15 personnel).

A second area of potential overall cost savings is in maintenance. Appendix C shows the number and type of maintenance actions performed on 25K loaders and WBELs at Dover from August 1996 to August 1997. According to Staff Sergeant Chris Champney (2001), a maintenance analyst in the 436th Transportation Squadron Maintenance Control and Analysis Flight, the average cost for maintenance actions, per vehicle, equates to approximately $8,400 per year (3). This information indicates that the estimated cost for the 13 25K loaders equals $109,200, and the total estimated maintenance cost for the 3 WBEL equals $25,200 per year. Given this information, the elimination of 59 WBEL authorizations, along with the elimination of the estimated 15

manpower authorizations at the 3-level, equates to a potential savings of $848,706 per year (59 WBEL authorizations x $8,400 maintenance cost per year + $353,106).

Reduced Cargo Loading Times

Captain Todd Dyer (2000) conducted a study entitled "Materiel Handling Equipment Capabilities Study." The study examined the entire process of cargo loading, from the time the pallet was built at the aerial port facility, to the time it was loaded on the aircraft and the loader is pulled away from the aircraft. Dyer's study also includes the movement of cargo from a pallet grid system to the designated aircraft. A pallet grid system is a series of designated pallet positions established in a cargo marshalling area, or yard. When cargo is load planned for a particular aircraft, each pallet is placed in a designated spot in the grid system. Once the grid system is full, the pallets are loaded onto the K loader in the order in which they will be loaded onto the aircraft. The grid system provides a sequence in which the pallets will be loaded onto the aircraft. The purpose of Dyer's study was to determine the loading capabilities of various pieces of MHE based on the number of personnel available to perform the loading tasks in the entire process. The analysis of Dyer's study will focus on the capabilities of the 25K loader and WBEL, in terms of the loading times required for various aircraft that require high-reach loading capable MHE. The analysis will also examine the capabilities of the NGSL, given the same aircraft and same number of personnel available.

Dyer's MHE capabilities study measured the amount of time it takes for the 25K loader and WBEL to upload cargo on various wide-bodied aircraft. The study stipulates that there is a 17-step process involved in the process of preparing and loading cargo. The process begins at the time when the first pallet of cargo is built at the aerial port. The

process ends when the last pallet is loaded onto the aircraft and the loader is pulled away from the aircraft. Appendix D is a description of the 17-step process. The performance of the 25K loader and the WBEL is based on the availability of personnel required in the loading process. The assumption for the loading process is that it requires 12 personnel to perform the loading tasks. Three personnel are required to build the pallets. Three personnel are required to operate three 10K forklifts, which move the pallets from the grid to the loader. Two personnel are required to operate the WBEL. This assumes that the Cochran WBEL is used for the study. One person is required to operate the 25K loader. One person is required to act as a spotter for the MHE. One person is needed to push the pallets from the 25K loader to the WBEL. Finally, one person is on the ramp at all times, acting as the loading crew chief. Table 12 shows the amount of time, in hours, needed to load the number of pallet positions available, based on the type or aircraft.

Table 12. Estimated 25K Loader/WBEL Loading Times

Aircraft Type	Pallet Positions	25% Personnel Available	50% Personnel Available	75% Personnel Available	90% Personnel Available
KC-10	25	8.56 hrs	5.51 hrs	5.24 hrs	4.37 hrs
B-747	42	15.44 hrs	10.18 hrs	9.30 hrs	8.08 hrs
B-767	24	8.35 hrs	5.37 hrs	5.11 hrs	4.26 hrs
DC-10	30	10.44 hrs	7.01 hrs	6.28 hrs	5.33 hrs
L-1011	26	9.18 hrs	6.05 hrs	5.37 hrs	4.49 hrs
MD-11	35	12.31 hrs	8.11 hrs	7.33 hrs	6.28 hrs

Source: FMC Commander 30 Universal Loader Operations Utility Evaluation. 1998. Used as basis for "Materiel Handling Equipment Capabilities Study", Todd Dyer, 2000.

The percentages at the top of the table indicate the percent of personnel available during the loading process. For example, twenty-five percent personnel available indicates that three of the total 12 people are available to perform the cargo loading tasks. Fifty percent

indicates six people are available, seventy-five percent indicates that nine people are available, and ninety percent indicates 11 people are available. These percentages of personnel available represent worst case/best case deployment situations. The information from Table 12 shows that to load a B-747, with 44 pallet positions available, would take 15.44 hours if only twenty-five percent of the total personnel (three workers) were available to perform the loading operations. However, if ninety percent of the total personnel (11 people) were available to load the B-747, it would take 8.08 hours. Again, this assumes that only one 25K loader and one WBEL are used for the operation.

Table 13 demonstrates the capabilities of the NGSL, given the same aircraft and percentages of personnel available. The data shows that to load a B-747 with only ten percent total personnel available (three people), it takes 12.1 hours. To load the B-747 with ninety percent personnel available (11 people) takes 6.17 hours.

Table 13. Estimated NGSL Loading Times

Aircraft Type	Pallet Positions	25% Personnel Available	50% Personnel Available	75% Personnel Available	90% Personnel Available
KC-10	25	6.54 hrs	4.31 hrs	4.1 hrs	3.34 hrs
B-747	42	12.1 hrs	7.57 hrs	7.2 hrs	6.17 hrs
B-767	24	6.38 hrs	4.2 hrs	4 hrs	3.26 hrs
DC-10	30	8.17 hrs	5.25 hrs	5 hrs	4.17 hrs
L-1011	26	7.11 hrs	4.42 hrs	4.2 hrs	3.43 hrs
MD-11	35	9.4 hrs	6.19 hrs	5.5 hrs	5 hrs

Source: Captain Todd Dyer. "Materiel Handling Equipment Capabilities Study". 2000.

A comparison of the tables demonstrates a noticeable reduction in loading times when the NGSL is utilized. The importance of the reduction of loading times could possibly translate into quicker turnaround times for cargo aircraft. Quicker turnaround times translates into increased sortie usage for the aircraft, which, in turn, translates to

more cargo being delivered to its destination. Table 14 demonstrates the difference, in hours, between the performance capabilities of the 25K loader/WBEL and the NGSL.

Table 14. Differences in 25K Loader/WBEL and NGSL Loading Capabilities

Aircraft Type	Pallet Positions	Type Loader	25% Personnel Available	50% Personnel Available	75% Personnel Available	90% Personnel Available
KC-10	25	25K/WBEL	8.56 hrs	5.51 hrs	5.24 hrs	4.37 hrs
		NGSL	6.54 hrs	4.31 hrs	4.1 hrs	3.34 hrs
		Difference	**2.02 hrs**	**1.2 hrs**	**1.14 hrs**	**1.03 hrs**
B-747	42	25K/WBEL	15.44 hrs	10.18 hrs	9.3 hrs	8.08 hrs
		NGSL	12.1 hrs	7.57 hrs	7.2 hrs	6.17 hrs
		Difference	**3.34 hrs**	**2.51 hrs**	**2.1 hrs**	**1.91 hrs**
B-767	24	25K/WBEL	8.35 hrs	5.37 hrs	5.11 hrs	4.26 hrs
		NGSL	6.38 hrs	4.2 hrs	4 hrs	3.26 hrs
		Difference	**1.97**	**1.17 hrs**	**1.11 hrs**	**1.0 hrs**
DC-10	30	25K/WBEL	10.44 hrs	7.01 hrs	6.28 hrs	5.33 hrs
		NGSL	8.17 hrs	5.25 hrs	5.0 hrs	4.17 hrs
		Difference	**2.27 hrs**	**1.76 hrs**	**1.28**	**1.16 hrs**
L-1011	26	25K/WBEL	9.18 hrs	6.05 hrs	5.37 hrs	4.49 hrs
		NGSL	7.11 hrs	4.42 hrs	4.2 hrs	3.43 hrs
		Difference	**2.07 hrs**	**1.63 hrs**	**1.17 hrs**	**1.06 hrs**
MD-11	35	25K/WBEL	12.31 hrs	8.11 hrs	7.33 hrs	6.28 hrs
		NGSL	9.4 hrs	6.19 hrs	5.5 hrs	5.0 hrs
		Difference	**2.91 hrs**	**1.92 hrs**	**1.83 hrs**	**1.28 hrs**

Cargo Capacity

The 25K loader and the NGSL have the capability to deploy on C-130, C-141, C-17, and C-5 aircraft. However, for either the 25K loader or the NGSL to be fully utilized, they must have the capability to interface with both commercial and military cargo aircraft. As stated earlier, the NGSL possess the ability to interface with commercial narrow and wide-bodied cargo aircraft. Its platform can be raised to the cargo floor level of all military and commercial cargo aircraft. The 25K loader, on the other hand, cannot interface with commercial wide-bodied cargo aircraft or the KC-10. It must rely on the WBEL to raise the cargo to the aircraft floor level. In a tactical airlift

scenario, in which C-130 aircraft are used to deliver cargo to intratheater bases, the capabilities of the NGSL are very attractive. Assuming a forward base has the capability to accept all types of commercial and military cargo aircraft, a small fleet of NGSLs could reasonable handle the cargo flow. If only 25K loaders were employed at a forward base, they could only be fully utilized in combination with a WBEL. Additionally, the WBEL would take up space on the deploying aircraft. Table 15 is a breakdown of the amount of cargo deployed from Dover in support of Operation ALLIED FORCE.

Table 15. Dover Cargo Movement Record, Operation ALLIED FORCE

Date	Weight of Cargo (lbs)	Aircraft Type	Number pallets moved
3 March 1998	117,760	C-5	12
3 April 1998	67,358	C-17	7
4 April 1998	180,720	C-5	19
4 April 1998	65,805	C-17	7
4 April 1998	165,170	B-747	17
5 April 1998	172,585	B-747	17
6 April 1998	169,135	B-747	17
7 April 1998	174,345	B-747	18
8 April 1998	176,445	B-747	18
10 April 1998	166,920	B-747	17
10 April 1998	152,615	B-747	16
11 April 1998	21,846	C-141	3
12 April 1998	48,895	C-5	5
2 May 1998	184,050	B-747	19
11 May 1998	175,021	B-747	18
12 May 1998	171,850	B-747	18
13 May 1990	170,850	B-747	18
14 May 1998	167,405	B-747	17
17 May 1998	81,240	DC-8	9
17 May 1998	170,605	B-747	18

Source: 436 APS Data Records and Analysis, Dover Air Force Base, 2001

For this period of time, the B-747 was the primary cargo mover. The amount of cargo listed above represents a rapid response to a contingency scenario. This analysis will assume that the represented cargo was deployed to a forward airfield, which has the capability to accept commercial cargo aircraft. Given that scenario, either the NGSL

itself, or the combination of the 25K loader and WBEL, would be required to download the aircraft. This scenario also assumes that the Tunner 60K is not employed at the forward base.

According to Captain Jeff Russell (2000), a Cochran WBEL utilizes six pallet positions aboard a C-17, when the aircraft is configured in a center-line, airdrop configuration (23). MHE cannot be transported aboard commercial cargo aircraft. Assuming that the forward base operates with a working MOG of three aircraft, it would take a fleet of six 25K loaders and two WBELs to handle the cargo flow, as demonstrated by the amount of cargo moved during Operation ALLIED FORCE. The above cargo does not include the movement of MHE to the forward airfield. If a fleet of six 25K loaders and two WBELs deployed to the forward location, their combined capacity would limit the military aircraft by 38 pallet positions, for a maximum weight of 380,000 pounds. Deployment of the WBELS also would reduce cargo capacity by 12 pallet positions for a maximum total weight of 120,000 pounds. Assuming the space restrictions are the same for the NGSL and 25K Loader, a fleet of six NGSLs would perform the same amount of work as a fleet of six 25K loaders. The difference is that the NGSL would not require the WBEL to load or unload commercial aircraft. The cargo aircraft typically will bulk out its space constraints before it maximizes its weight constraints. Therefore, the savings, in terms of cargo capacity, would be 12 pallet positions, for a maximum weight of 120,000 pounds, for a small contingency deployment, as in the case of the initial buildup during Operation ALLIED FORCE. This equates to a savings of two C-130 equivalents, which could be utilized for intratheater airlift.

Reduction in Vehicle Authorizations

The 1998 Worldwide MHE Conference Requirements Validation (27:15), shows the total amount of cargo loading MHE, which includes the Tunner 60K, the 40K loader, the 25K loader, the NGSL, and the WBEL. The totals are listed in Table 16. These requirements are based on the needs of all authorizations for all Air Force bases, which have a requirement for MHE. The chart shows that in 1998, 40K authorizations had been reduced to 13 due to the advent of the Tunner 60K loader. Worldwide 25K loader authorizations were determined to be 692. Since the NGSL had not been developed at the time, there were no authorizations anywhere for the NGSL. WBEL authorizations were set at 64.

The MHE requirements, for the 2000 Worldwide MHE Conference Requirements Validation, indicate that the number of 25K loader authorizations dropped to 499, while NGSL authorizations were determined to be 219. Additionally, the WBEL authorizations dropped to one, located at Cape Canaveral, Florida (28:4). Table 16 also lists the 1998 Worldwide MHE Conference Requirements Validation.

Table 16. Worldwide MHE Conference Requirements Validation

Conference	25K Loader	40 Loader	NGSL	WBEL	Tunner 60K
1998	692	13	---	64	318
2000	499	15	219	1	318

Source: 1998, 2000 Worldwide MHE Conference Requirements Validation.

In an analysis of MHE requirements by Major Laura Suzuki (1998), several proposals were made concerning the optimal amount of NGSLs to meet present and future cargo loading requirements. According to Suzuki, the ratio of small loaders to large loaders is important because the overall fleet bias is towards small loaders (26:15).

Small loaders are more flexible, but less efficient. Suzuki based the study on the existing constraints for loaders, at that time. These constraints include: 1) a minimum throughput for the loaders, based on approximately 1455 25K loader equivalents; 2) minimum high-reach capabilities were approximately 514 loaders; 3) minimum heavy lift loaders were 268; 4) minimum number of NGSLs to buy was 82; 5) at the time, 103 Tunner 60K loaders were on contract; 6) the AMC Commander made a business agreement to purchase 252 Tunner 60K loaders. Based on these constraints, Major Suzuki's study presented five possible options.

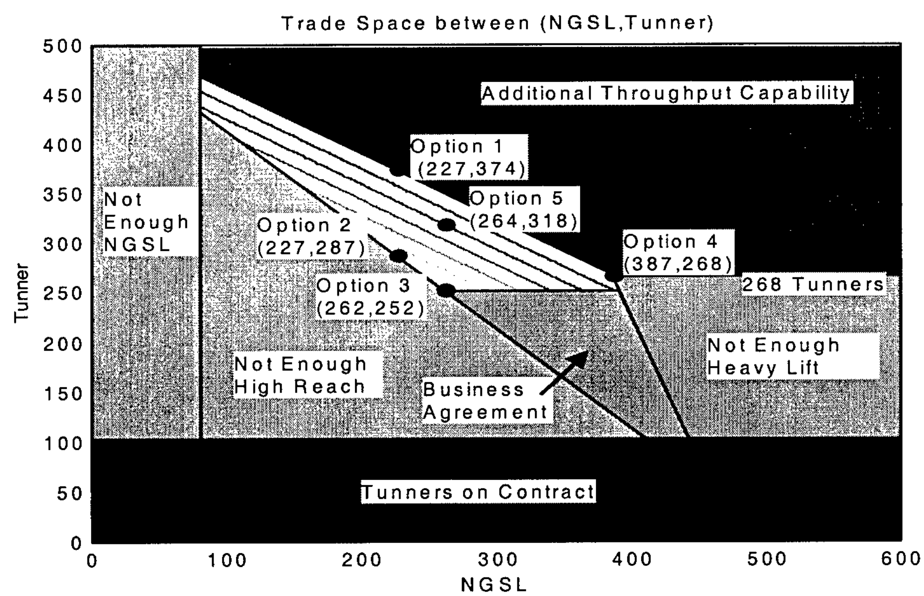
Option 1 was to retire all 40K loaders. This option required a purchase of 234 Tunner 60K loaders and 227 NGSLs. This option also suggested keeping 528 25K loaders. The fewer number of loader types in the fleet makes maintenance and training easier. However, Suzuki states it is difficult to quantify the advantages in terms of throughput. The Tunner 60K loaders would be stationed at big aerial ports, while the NGSLs and 25K loaders would be stationed at smaller aerial ports. This option was the most expensive in terms of short-term acquisition costs (26:slide 18).

Option 2 sought to minimize high-reach loaders to 514 by reducing the overall Tunner 60K loader buy. This option sought to obtain 287 Tunner 60K loaders, 227 NGSLs, keep 108 40K loaders, and keep 528 25K loaders. Keeping the 40K loaders supported throughput requirements, but also required training and maintenance of the 40K loader fleet. This option was much less expensive than Option 1 in short-term acquisition costs (26:slide 22).

Option 3 sought to acquire 252 Tunner 60K loaders, maintaining a minimum high-reach loader capability of 514 loaders. This option would purchase 252 Tunners,

262 NGSLs, keep 124 40K loaders, and keep 528 25K loaders. This option is the least expensive in short-term acquisition costs. It yields sufficient loaders to meet requirements, while allowing time to analyze Tunner 60K loader and NGSLs performance in the field. However, this option would require additional buys within 10-30 years (26:slide 25).

Option 4 sought to eliminate all 40K loaders. This option allowed for the purchase of 268 Tunner 60K loaders and 387 NGSLs. This option had a heavy bias toward the smaller loaders because it also suggested keeping 528 25K loaders (26:slide 28).



Source: Major Laura Suzuki. "Briefing on MHE Requirements Analysis". Headquarters Air Mobility Command, Studies and Analysis Flight. Scott Air Force Base, Illinois. 6 November 1998. Slide number 16.

Figure 1. Optimal NGSL/Tunner 60K Loader Mix

Option 5 was to purchase 318 Tunner 60K loaders, 264 NGSL, keep 39 40K loaders, and keep 528 25K loaders. This option reflects an increase in cargo-loading requirements over the other four options (26:slide 30). Figure 1 above illustrates the various options, and the decision to choose the optimal amount (Option 5) of NGSLs, based on the six constraints mentioned above.

The decision to purchase 264 NGSLs, which would replace 264 25K loader and 59 WBEL authorizations would affect Dover's authorizations by eliminating all four current WBEL authorizations. Based on the 2000 Worldwide MHE Conference Requirements Validation, 12 NGSLs would replace 12 of Dover's 25K loaders, leaving three 25K loaders. However, all four WBEL authorizations would be eliminated.

Summary

The advent of an Expeditionary Air Force (AEF) places greater emphasis on the Air Force's ability to provide Rapid Global Mobility (RGM). Elimination of overseas bases requires the Air Force to maintain a highly agile and mobile force. Reducing the logistics tail, in support of RGM, requires an overall reduction in the mobility footprint. The NGSL plays an important role in reducing the mobility footprint. The NGSL meets the requirements set forth by the Air Force to support not only cargo-loading operations during peacetime, but also during contingency operations. The NGSL will provide the theater CINC with a flexible intratheater response to cargo-loading operations. The capability of the NGSL to incorporate the technology of two loaders into one piece of MHE makes the NGSL more valuable because it reduces the number of personnel needed to operate and maintain it, as well as reducing cargo-loading times, and freeing up more

capacity on cargo aircraft, when it is transported. Table 17 is a summary of the benefits of the NGSL in reducing the mobility footprint.

Table 17. Summary of the Benefits of the NGSL in Reducing the Mobility Footprint

Area of Analysis	Benefit
Reduction in Manpower	Use of NGSL versus use of 25K loader/WBEL on flightline can reduce loading crew size from nine to six. Estimated reduction of manpower authorizations Air Force-wide is 15 authorizations. Elimination of WBEL can reduce transportation squadron mechanics by one authorization.
Reduced Operating Cost	Elimination of 15 manpower authorizations at 3-level career progression equates to savings of $353,106 per year. Elimination of maintenance costs for 59 authorized WBELs equals $495,600 per year. Total savings equal $848,706 per year.
Reduced Cargo Load Times	Use of NGSL reduces loading times by over one hour, compared to 25K loader/WBEL combination.
Increased Cargo Capacity	Elimination of Cochran WBEL for deployment missions equals savings of six C-17 pallet positions, or one C-130 equivalent.
Reduce Vehicle Authorization	2000 Worldwide MHE Conference Requirements Validation advocates the NGSL should be utilized to replace 264 25K loader authorizations and eliminate 59 WBEL authorization, further reducing the 1998 requirements authorizations by 37 vehicles.

V. Conclusions and Recommendations

Overview

The purpose of this chapter is to discuss the conclusions drawn from the analysis of the NGSL in reducing the mobility footprint. This chapter will also present the limitation of this study, as well as preset suggestions for future research into the study and analysis of the NGSL in reducing the mobility footprint and enhancing cargo-loading operations.

Conclusions

It is clear that the Air Force's fleet of cargo loading MHE, with the exception of the Tunner 60K loader, must be modernized. The development of the NGSL, with its capability of combining a small loader with high-reach ability, would greatly aid in the modernization of the cargo-loading MHE fleet. The NGSL will make cargo-loading operation more efficient in two ways. The first way is that it will reduce the amount of MHE needed to perform cargo-loading operation. Essentially, the NGSL will combine the capabilities of both the 25K loader and the WBEL. Second, the NGSL will reduce the number of personnel needed to operate and maintain it. The reduction of required loaders and personnel to operate and maintain them equates to a reduction in the mobility footprint. As defined by this study, reduction of the mobility footprint includes reduced manpower, reduced overall operating cost, reduced cargo-loading ground times, increased cargo aircraft capacity, and reductions in vehicle authorizations.

An analysis of the typical daily peacetime cargo flow at the 436th Aerial Port Squadron at Dover Air Force Base, Delaware, shows that six cargo aircraft are processed in a 24-hour period. The 24-hour period is divided into three shifts in duration of eight

working hours. Typically, a shift requires two crews of nine personnel to perform cargo-loading operations. Assuming that the operation is performed using only 25K loaders and WBELs, four 25K loader and one WBEL would be required. The WBEL, because of its size, would require two personnel to operate it. One person would drive the loader from the aerial port to the aircraft, while the other person ensures the WBEL meets clearance restrictions as it approaches the aircraft. However, the NGSL would combine the capability of both the 25K loader and the WBEL. For cargo-loading operations, the WBEL could be eliminated altogether. Assuming that the WBEL being used is a Cochran loader, as is used at Dover, two personnel could be eliminated in the place of the NGSL. Additionally, the number of personnel needed to maintain the WBEL could be reduced. An analysis of the maintenance actions for the WBELs at Dover from August 1996 to August 1997 shows that an estimated 2,979 manhours per year could be saved, if the WBEL authorizations are eliminated. The reduction in manpower to operate and maintain the NGSL is important because less manpower needed during peacetime operations may equate to less personnel required during contingency operations.

A reduction in manpower also translates to a reduction in overall operating cost. The estimate given by Major Michael Crupe, in terms of manpower authorizations reduced due to the elimination of the WBEL authorizations, is approximately 15 manpower authorizations. Although this does not appear to be significant in terms of overall manpower reductions, the potential savings to the Air Force, per year, is an estimated $848,706, taking into account the pay given to MHE mechanics, as well as the cost of fixing MHE. The overall savings, due to the capability of the NGSL, could possibly translate into money saved, which could be allocated to other mobility

maintenance programs. This would ensure the Air Force's capability to deploy in a rapid-response contingency, does not decrease.

The biggest contribution the NGSL will make toward the reduction of the mobility footprint is in the area of reduced cargo-loading times. Captain Todd Dyer performed a study, which analyzed the capabilities of the 25K loader in loading various commercial and military cargo aircraft. His study determined the number of pallets that could be loaded on the various aircraft, within a certain processing time. His study also shows how long it would take to load the target number of pallets, by percentile. The information gathered by Captain Dyer was used to estimate the capabilities of the NGSL. The data shows that the amount of time the NGSL loads the same number of pallets with the 25K loader and WBEL is greatly reduced. This reduction in loading times equates to more efficient loading operations, as well as a quicker turnaround time for cargo aircraft. The less time a cargo aircraft spends on the ground increases its capability to deliver more cargo.

The NGSL was designed to be transportable on all military cargo aircraft, with the exception of the KC-10. Of particular importance is its ability to travel on C-130 aircraft. This is important because it enhances intratheater airlift capabilities. The NGSL takes up less aircraft space, compared to the 25K loader and the WBEL, when they travel together. Based on information concerning the data from Operation ALLIED FORCE, a fleet of six 25K loaders and two WBELs, deploying in support of contingency operations, would limit aircraft cargo capacity by 38 pallet positions, or a maximum of 380,000pounds. Deployment of the NGSL by itself, given the same conditions as the Operation ALLIED FORCE example, would save 12 pallet positions, for a maximum savings of 120,000

pounds. The savings, in terms of aircraft capacity, would allow for a greater amount of cargo to be airlifted, if needed, while not increasing the number of sorties required to airlift the cargo.

The last area in the reduction of the mobility footprint is in overall vehicle authorization reductions. Based on information from the 1998 and 2000 Worldwide MHE Conference Requirements Validation, the NGSL will replace 264 25K loader authorizations in a one-for-one swap. Additionally, 59 WBEL authorizations will be eliminated altogether. The reduction of 59 WBEL authorizations represents a significant amount of MHE that will be replaced by advanced MHE technology.

Limitations

The greatest limitation to this study is due to the NGSL not being fielded yet. The information, concerning the NGSL's performance, has been estimated. Additionally, information on the NGSL's potential maintenance costs, per year, has not been determined. In April of 2001, Dover Air Force Base will conduct a 3-month operational test and evaluation of the NGSL's capabilities. During this period, much of the maintenance information will become available. Another limitation is that the NGSL has not been tested in a contingency operation. The similar capabilities between the NGSL and the 25K loader, have provided estimates on how well the NGSL will perform. A third limitation to this study is due to the heavy use of the Tunner 60K loader at Dover. Although Dover maintains four Cochran WBEL loaders, they are not used as frequently as they were before the arrival of the Tunner 60K loader. The Tunner 60K loader has proved that its high-reach capabilities have greatly increased the efficiency of cargo-

loading operations. The NGSL will provide even greater overall high-reach capability, while providing a high degree of flexibility with its small size.

Recommendations

Based on the advanced capabilities of the NGSL, it is recommended that the Air Force continue to produce the NGSL and get it fielded as soon as possible. It is no longer feasible to continue to overhaul MHE that has exceeded its life expectancy. The technology associated with the NGSL will help keep pace with current mobility requirements. The potential operating cost savings the NGSL will produce, in terms of manpower and maintenance costs, could offset the cost of production, thereby allowing the NGSL to be produced at a greater delivery rate. Additionally, having NGSL capability within theater areas of responsibility allows the theater CINC the flexibility to allocate cargo-loading resources as required. Overseas NGLS assets should not be managed as War Readiness Materiel (WRM) have been managed in the past. WRM assets typically remain idle, until either called upon during a contingency, or used to fill a vacant authorization. NGSLs will greatly enhance mobility cargo loading operations. Therefore, they should be fully utilized, and not allowed to sit idle for long periods of time.

Future Research

Study and analysis of the benefits of the NGSL must continue. The technology associated with high-reach loader capability is not new. The Tunner 60K loader has proven itself to be highly efficient. However, what has not been studied is how the NGSL will affect mobility planning. The process of deliberate planning must now be re-evaluated. The advent of the NGSL will require the Air Force to re-evaluate how it

manages and allocates mobility resources. If the NGSL does provide for reductions in manpower, increases aircraft capacity, decreases vehicle authorizations, and decreased ground cargo-loading operations, then each base where the NGSL is assigned, must revise its War Operations Plan. Utilization of the NGSL will require the revision of Time Phased Force Deployment Documents (TPFDD), which not only affect Air Force operational plans, but will also affect the operational plans of Army, Navy, and Marine Corps. Additionally, models of how the NGSL will be utilized, during contingency operations, could also be explored.

Appendix A. List of Acronyms

ACAT	Acquisition Category
AFLMA	Air Force Logistics Management Agency
AFOTEC	Air Force Operational Test and Evaluation Center
AFSC	Air Force Specialty Code
AMC	Air Mobility Command
APOD	Aerial Port of Debarkation
ASC	Aeronautical Systems Center
ATT	Advanced Tactical Transporter
CENTAF	Central Command Air Forces
CINC	Commander-in-Chief
COTS	Commercial-off-the-shelf
CRAF	Civil Reserve Air Fleet
DoD	Department of Defense
EAF	Expeditionary Air Force
ITV	Intransit Visibility
JCS	Joint Chiefs of Staff
MAC	Military Airlift Command
MAJCOM	Major Command
MOG	Maximum on Ground
MHE	Materiel Handling Equipment
MMHS	Mechanized Materiel Handling System
MTBF	Mean Time Between Failure
MTBCF	Mean Time Between Critical Failure
MTW	Major Theater of War
NCA	National Command Authority
NDI	Non Developmental Item
NGSL	Next Generation Small Loader
OA	Operational Assessment
PACAF	Pacific Air Forces
PEO	Program Executive Officer
RAF	Royal Air Force
RGM	Rapid Global Mobility
R-TOC	Reduction in Total Ownership Cost
SPO	Special Projects Office
TACLOP	Truck-Aircraft Loading, Off Pavement
TCTO	Time Compliance Technical Order
TPFDD	Time Phased Force Deployment Document
ULD	Unit Load Device
USAFE	United States Air Forces Europe
WBEL	Wide Body Elevator Loader
XPY	Studies and Analysis Flight

Appendix B. Dover Air Force Base
MHE Qualification, January 2000

AFSC	25K Qual	40K Qual	WBEL Qual	60K Qual
2T271	Yes	Yes	No	No
2T271	Yes	Yes	No	No
2T271	Yes	Yes	No	Yes
2T271	No	No	No	No
2T271	Yes	Yes	No	No
2T271	Yes	Yes	Yes	No
2T271	Yes	Yes	Yes	Yes
2T271	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	Yes	Yes
2T251	No	No	No	No
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	No
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	No
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	No
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes

Appendix B. Dover Air Force Base MHE Qualification, January 2000 (Con't)

AFSC	25K Qual	40K Qual	WBEL Qual	60K Qual
2T251	Yes	Yes	No	No
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	No
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	Yes	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T251	Yes	Yes	No	Yes
2T231	Yes	Yes	No	Yes
2T231	No	No	No	No
2T231	Yes	Yes	No	No
2T231	No	No	No	No
2T231	No	No	No	No
2T231	No	No	No	No
2T231	No	No	No	No
2T231	Yes	Yes	No	No
2T231	Yes	Yes	No	Yes
2T231	Yes	Yes	No	Yes
2T231	Yes	Yes	No	No
2T231	Yes	Yes	No	Yes
2T231	No	No	No	No
CIV	Yes	Yes	Yes	Yes
CIV	Yes	Yes	Yes	Yes
CIV	Yes	Yes	Yes	Yes
CIV	Yes	Yes	Yes	Yes
CIV	Yes	Yes	Yes	Yes
CIV	Yes	Yes	Yes	No
CIV	No	No	No	No
CIV	No	No	No	No

Appendix C. Dover AFB 25K Loader/WBEL Maintenance Actions, Aug 1996-Aug 1997

REG No.	Vehicle	Mgt Code	Date	Sys Code	Action Code	Job Description	
84E00414	EME 25K	E935	09 Aug 96	18AA	R	REPLACE:	WHEEL/TRACK :FRONT TIRE:LEFT
			24 Sep 96	01IA	R	REPLACE:	ENGINE:GASKET:CYLINDER HEAD
			28 Sep 96	20HZ	T	TROUBLESHOOT:	BRAKE:PARK:OTHER
			01 Apr 97	23AL	G	REPAIR:	HYDRAULIC:SYSTEM:COMPLETE
				41LA	T	TROUBLESHOOT:	463L/MHE:PLATFORM:BED
			10 Apr 97	20HD	R	REPLACE:	BRAKE:PARK:VALVE
				23CG	R	REPLACE:	HYDRAULIC:PUMP:ASSEMBLY
				20HD	T	TROUBLESHOOT:	BRAKE:PARK:VALVE
				20HZ	S	SERVICE:	BRAKE:PARK:OTHER
			14 Apr 97	20HZ	G	REPAIR:	BRAKE:PARK:OTHER
				23CD	G	REPAIR:	HYDRAULIC:PUMP:SEAL
				43AZ	S	SERVICE:	OTHER:INCOMING:OTHER
			08 May 97	20HYZ	T	TROUBLESHOOT:	BRAKE:PARK:SHOE/PADS
				20HD	R	REPLACE:	BRAKE:PARK:VALVE
				20GF	R	REPLACE:	BRAKE:CALIPER:BOTH REAR
			04 Jun 97	10AF	T	TROUBLESHOOT:	STARTING:SYSTEM:COMPLETE
				10AC	R	REPLACE:	STARTING:SYSTEM:RELAY
			19 Jun 97	23GH	R	REPLACE:	HYDRAULIC:LIFT CYL:LINE
			08 Jul 97	43AB	I	INSPECT:	OTHER:INCOMING:ACCIDENT ESTIMAT
			24 Jul 97	29FZ	G	REPAIR:	BODY:BUMPER:OTHER
			29 Jul 97	41IZ	R	REPLACE:	463L/MHE:PALLET STOP:OTHER
			29 Aug 97	43AZ	I	INSPECT:	OTHER:INCOMING:OTHER
85E00021	EME 25K	E935	09 Oct 96	20HZ	G	REPAIR:	BRAKE:PARK:OTHER
			15 Oct 96	43BG	I	INSPECT:	OTHER:LTI:MOBILITY
			30 Oct 96	41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
			14 Nov 96	43BH	I	INSPECT:	OTHER:LTI:TDY
			16 Dec 96	43BE	S	SERVICE:	OTHER:LTI:RECEIVING
				43BF	S	SERVICE:	OTHER:LTI:SHIPMENT
			23 Jul 97	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AB	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
85E00107	EME 25K	E935	02 Aug 96				
			24 Sep 96	41LZ	G	REPAIR:	463L/MHE:PLATFORM:OTHER
			05 Nov 96	23BA	G	REPAIR:	HYDRAULIC:RESERVOIR:SIGHT GLASS
				29HC	R	REPLACE:	BODY:GLASS:RIGHT DOOR
			05 Apr 97	29HC	R	REPLACE:	BODY:GLASS:RIGHT DOOR
			06 Aug 97	05JH	R	REPLACE:	FUEL:ACCELERATOR:THROTLE SOLENIOD

Appendix C. Dover AFB 25K Loader/WBEL Maintenance Actions, Aug 1996-Aug 1997 (Con't)

REG No.	Vehicle	Mgt Code	Date	Sys Code	Action Code	Job Description	
			28 Sep 96	20HZ	T	TROUBLESHOOT:	BRAKE:PARK:OTHER
			15 Nov 96	20HZ	G	REPAIR:	BRAKE:PARK:OTHER
				20HZ	T	TROUBLESHOOT:	BRAKE:PARK:OTHER
			07 Apr 97	41KA	R	REPLACE:	463L/MHE:ELECTRICAL:CTRL VALVE F/CYL
				20HF	L	ADJUST:	BRAKE:PARK:SHOE/PADS
			01 Jul 97	29HA	R	REPLACE:	BODY:GLASS:WINDSHIELD
				05JZ	T	TROUBLESHOOT:	FUEL:ACCELERATOR:OTHER
							INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
			08 Aug 97	41LI	R	REPLACE:	463L/MHE:PLATFORM:LADDER
85E00805	EME 25K	E935	12 Aug 96	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AB	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
			15 Oct 96	43BG	I	INSPECT:	OTHER:LTI:MOBILITY
			02 Dec 96	41ID	G	REPAIR:	463L/MHE:PALLET STOP:CABLE
			28 Mar 97	29HB	R	REPLACE:	BODY:GLASS:LEFT DOOR
			07 Apr 97	41KB	R	REPLACE:	463L/MHE:ELECTRICAL:CTRL VALVE R/CYL
			12 May 97	08BI	R	REPLACE:	ELECTRICAL:PANEL:SWITCH
			05 Jun 97	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AB	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
				29HB	R	REPLACE:	BODY:GLASS:LEFT DOOR
			27 Aug 97	12BZ	G	REPAIR:	TRANSMISSION:AUTOMATIC:OTH ER
85E00807	EME 25K	E935	12 Aug 96	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
				06BG	R	REPLACE:	CHARGING:ALTERNATOR:ASSEMB LY
				06AJ	T	TROUBLESHOOT:	CHARGING:SYSTEM:COMPLETE
			24 Sep 96	43BD	S	SERVICE:	OTHER:LTI:DEPOT REPAIR
				43AZ	S	SERVICE:	OTHER:INCOMING:OTHER
			06 May 97	43AC	I	INSPECT:	OTHER:INCOMING:ABUSE ESTIMATE
			09 May 97	29HB	R	REPLACE:	BODY:GLASS:LEFT DOOR
			20 May 97	43AZ	S	SERVICE:	OTHER:INCOMING:OTHER
			29 Jul 97	06BG	G	REPAIR:	

Appendix C. Dover AFB 25K Loader/WBEL Maintenance Actions, Aug 1996-Aug 1997 (Con't)

REG No.	Vehicle	Mgt	Date	Sys	Action	Job Description	
		Code		Code	Code		
				20HZ	G	REPAIR:	BRAKE:PARK:OTHER
			31 Mar 97	20CK	T	TROUBLESHOOT:	BRAKE:EMERGENCY:ASSEMBLY
				23AL	T	TROUBLESHOOT:	HYDRAULIC:SYSTEM:COMPLETE
				12CA	R	REPLACE:	TRANSMISSION:CONTROL:LINKAGE
				29BZ	R	REPLACE:	BODY:PANEL:OTHER
				20AG	T	TROUBLESHOOT:	BRAKE:DRUM:BOTH FRNT & REAR
				34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AB	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AH	S	SERVICE:	INSPECTION:USER SUPPLIED:
				20RA	R	REPLACE:	BRAKE:PADS/SHOES:FRONT
				20FE	R	REPLACE:	BRAKE:WHEEL CYLINDER:BOTH FRONT
				20SA	S	SERVICE:	BRAKE:SYSTEM:BLEED
				35AA	S	SERVICE:	INSPECTION:USER SUPPLIED:
				16FC	R	REPLACE:	DIFFERENTIAL AXL:SHAFT:OTHER
				23AZ	G	REPAIR:	HYDRAULIC:SYSTEM:OTHER
				23AZ	R	REPLACE:	HYDRAULIC:SYSTEM:OTHER
92E00081	SWM 25K	E935	27 Aug 96	41KZ	G	REPAIR:	463L/MHE:ELECTRICAL:OTHER
				12BP	G	REPAIR:	TRANSMISSION:AUTOMATIC:FILTER
				41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
			17 Sep 96	23AF	G	REPAIR:	HYDRAULIC:SYSTEM:HOSE
				12BP	G	REPAIR:	TRANSMISSION:AUTOMATIC:FILTER
			10 Oct 96	41LZ	G	REPAIR:	463L/MHE:PLATFORM:OTHER
				26BH	G	REPAIR:	WIPER/WASHER:WASHER:COMPLETE SYSTEM
				23AZ	G	REPAIR:	HYDRAULIC:SYSTEM:OTHER
			16 Oct 96	23AD	G	REPAIR:	HYDRAULIC:SYSTEM:FILTER
			26 Nov 96	23AD	G	REPAIR:	HYDRAULIC:SYSTEM:FILTER
				41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
			03 Dec 96	01JJ	R	REPLACE:	ENGINE:BELT:COMPLETE SET
			09 Apr 97	23AL	G	REPAIR:	HYDRAULIC:SYSTEM:COMPLETE
				10AF	G	REPAIR:	STARTING:SYSTEM:COMPLETE
				04BI	P	REMOVE&REINSTALL:	COOLANT:RADIATOR:ASSEMBLY
			22 Apr 97	10AF	T	TROUBLESHOOT:	STARTING:SYSTEM:COMPLETE
				02AC	R	REPLACE:	IGNITION:SYSTEM:SWITCH
			30 Apr 97	41DC	R	REPLACE:	463L/MHE:CARGO ROLLER:ROLLERS
				09JA	G	REPAIR:	LIGHTING:INTERIOR:INSTRUMENT LIGHT
				41LG	G	REPAIR:	463L/MHE:PLATFORM:REAR GRASSHOPPER
			05 May 97	43BF	S	SERVICE:	OTHER:LTI:SHIPMENT

Appendix C. Dover AFB 25K Loader/WBEL Maintenance Actions, Aug 1996-Aug 1997 (Con't)

REG No.	Vehicle	Mgt	Date	Sys	Action	Job Description	
		Code		Code	Code		
			06 Jun 97	41LA	R	REPLACE:	463L/MHE:PLATFORM:BED
				08CL	R	REPLACE:	ELECTRICAL:CONTROL:RELAY
			26 Jun 97	21AZ	T	TROUBLESHOOT:	WARNING DEVICE:HORN:OTHER
				23EZ	G	REPAIR:	HYDRAULIC:CYL GEN:OTHER
			01 Jul 97	06EB	G	REPAIR:	CHARGING:BATTERY:TRAY
				29VZ	R	REPLACE:	BODY:RAILS:OTHER
			24 Jul 97	16BL	R	REPLACE:	DIFFERENTIAL AXL:REAR:COVER GASKET
				41LG	G	REPAIR:	463L/MHE:PLATFORM:REAR GRASSHOPPER
				23GZ	R	REPLACE:	HYDRAULIC:LIFT CYL:OTHER
92E00082	SWM 25K	E935	31 Oct 96	06AJ	G	REPAIR:	CHARGING:SYSTEM:COMPLETE
				06CF	R	REPLACE:	CHARGING:REGULATOR:ASSEMBL Y
			12 Nov 96	43BH	I	INSPECT:	OTHER:LTI:TDY
			01 Jun 97	01JJ	R	REPLACE:	ENGINE:BELT:COMPLETE SET
			12 Jun 97	18BA	R	REPLACE:	WHEEL/TRACK :REAR TIRE:LEFT
			30 Jul 97	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
93E00113	SWM 25K	E935					
9300145	SWM 25K	E935	09 Aug 96	23EZ	R	REPLACE:	HYDRAULIC:CYL GEN:OTHER
				22CB	L	ADJUST:	AIR:LINE:SERVICE HOSE
				29VZ	M	MODIFY:	BODY:RAILS:OTHER
				08CL	G	REPAIR:	ELECTRICAL:CONTROL:RELAY
			30 Sep 96	01JJ	R	REPLACE:	ENGINE:BELT:COMPLETE SET
			08 Oct 96	41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
				41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
			10 Oct 96	18AB	R	REPLACE:	WHEEL/TRACK :FRONT TIRE:RIGHT
			22 Oct 96	01JJ	R	REPLACE:	ENGINE:BELT:COMPLETE SET
				23BE	S	SERVICE:	HYDRAULIC:RESERVOIR:ASSEMB LY
			24 Oct 96	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AB	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AC	S	SERVICE:	INSPECTION:USER SUPPLIED:
				43BH	I	INSPECT:	OTHER:LTI:TDY
			14 Apr 97	12BN	G	REPAIR:	TRANSMISSION:AUTOMATIC:OIL COOLER
			21 Apr 97	19BI	R	REPLACE:	STEERING:CYLINDER:ASSEMBLY
				43AZ	S	SERVICE:	OTHER:INCOMING:OTHER
			06 May 97	01JJ	R	REPLACE:	ENGINE:BELT:COMPLETE SET
87E00001	CSDL25K	E935	23 Nov 96	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF

Appendix C. Dover AFB 25K Loader/WBEL Maintenance Actions, Aug 1996-Aug 1997 (Con't)

REG No.	Vehicle	Mgt Code	Date	Sys Code	Action Code	Job Description	
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AB	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AE	S	SERVICE:	INSPECTION:USER SUPPLIED:
				06AJ	S	SERVICE:	CHARGING:SYSTEM:COMPLETE
				06EG	R	REPLACE:	CHARGING:BATTERY:NEW
			24 Jul 96	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
				35AE	S	SERVICE:	INSPECTION:USER SUPPLIED:
			13 Aug 96	17HB	R	REPLACE:	SUSPENSION:STABILIZER:REAR
91E01027	CSDL25K	E935	01 Nov 96	41GC	R	REPLACE:	463L/MHE:CARRIAGE:CHAINS
			01 Jun 97	18BD	R	REPLACE:	WHEEL/TRACK :REAR TIRE:L/OUTSIDE DUAL
			01 Jun 97	05LU	G	REPAIR:	FUEL:DELIVERY:ASSEMBLY
				05JH	R	REPLACE:	FUEL:ACCELERATOR:THROTLE SOLENIOD
82E00145	COC LDR	E972	15 Oct 96	43BG	I	INSPECT:	OTHER:LTI:MOBILITY
			24 Oct 96	34AA	S	SERVICE:	INSPECTION:PERIODIC:SCHEDULE/ LOF
				34AB	S	SERVICE:	INSPECTION:PERIODIC:ANNUAL INSPCTION
				35AD	S	SERVICE:	INSPECTION:USER SUPPLIED:
				43BH	I	INSPECT:	OTHER:LTI:TDY
			05 Aug 97	06EG	R	REPLACE:	CHARGING:BATTERY:NEW
				41LZ	G	REPAIR:	463L/MHE:PLATFORM:OTHER
				41KI	G	REPAIR:	463L/MHE:ELECTRICAL:WIRING
82E00151	COC LDR	E972	06 Dec 96	18EZ	R	REPLACE:	WHEEL/TRACK :SPROCKET ASSY:OTHER
			18 Dec 96	08CO	R	REPLACE:	ELECTRICAL:CONTROL:SWITCH
				41LZ	G	REPAIR:	463L/MHE:PLATFORM:OTHER
				41JZ	T	TROUBLESHOOT:	463L/MHE:MOBLTY/TRVL REST:OTHER
			14 Apr 97	06EG	R	REPLACE:	CHARGING:BATTERY:NEW
			21 Apr 97	18AC	R	REPLACE:	WHEEL/TRACK :FRONT TIRE:TIRE ONLY W/O
			08 Aug 97	18IB	R	REPLACE:	WHEEL/TRACK :CASTER WHEEL:R/FRONT
82E00160	COC LDR	E972	17 Sep 96	41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
			30 Oct 96	41LZ	R	REPLACE:	463L/MHE:PLATFORM:OTHER
				23HZ	G	REPAIR:	HYDRAULIC:MOTOR:OTHER
			21 Apr 97	18AC	R	REPLACE:	WHEEL/TRACK :FRONT TIRE:TIRE ONLY W/O
			07 Jul 97	43BH	S	SERVICE:	OTHER:LTI:TDY
				23AF	G	REPAIR:	HYDRAULIC:SYSTEM:HOSE
			24 Jul 97	41LD	R	REPLACE:	463L/MHE:PLATFORM:ROLLERS & TRAY

Appendix D. MHE Capabilities Study Process

Grid Process
Step 1. Create pallets
Step 2. Forklifts move grid to loader
Step 3. Pallets wait for loader

Load loader at grid process
Step 4. Load single pallets onto loader
Step 5. Check pallet sequences for errors
Step 6. Correct pallet sequence errors
Step 7. Check for loader failure/error
Step 8. Correct error, if possible
Step 9. Hold loader until full of pallets
Step 10. Travel to aircraft

Unload loader at aircraft process
Step 11. Wait to position loader
Step 12. Position loader at aircraft
Step 13. Wait to unload loader
Step 14. Unload loader
Step 15. Placeholder for pallet errors
Step 16. Wait for disposition from aircraft
Step 17. Disposition

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Vita

Captain Victor Anthony Anaya is from Santa Fe, New Mexico. He graduated from the University of New Mexico in 1989 with a Bachelor of Arts degree in Political Science and English. He entered military service in 1990 through Basic Military Training School at Lackland Air Force Base, Texas. In June of 1994 Captain Anaya attended Officer Training School at Maxwell Air Force Base, Alabama. Upon his commissioning, he was assigned to the 377th Air Base Wing, Kirtland Air Force Base, New Mexico. Here he served as the Transportation Squadron's Combat Readiness and Resources Flight Chief, and the Vehicle Maintenance Flight Chief. He later served as the 377th Air Base Wing Executive Officer.

In August of 1997, Captain Anaya received an assignment to the 22nd Air Refueling Wing, McConnell Air Force Base, Kansas. Here he served as the Transportation Squadron's Combat Readiness and Resources Flight Chief. He deployed to Prince Sultan Air Base, Kingdom of Saudi Arabia, as the Vehicle Operations Flight Chief. Upon his return, he served as the 22nd Logistics Group Executive Officer.

Captain Anaya was selected to attend the Air Force Institute of Technology at Wright-Patterson Air Force Base, Ohio in September of 1999, and graduated with a Masters degree in Logistics Management in March of 2001. His follow-on assignment was to the Transportation Directorate, Headquarters Air Combat Command, Langley Air Force Base, Virginia.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*
20-03-2001

2. REPORT TYPE
Master's Thesis

3. DATES COVERED *(From – To)*
August 2000-March 2001

4. TITLE AND SUBTITLE
ANALYSIS OF THE NEXT GENERATION SMALL LOADER (NGSL) IN REDUCING THE MOBILITY FOOTPRINT

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Anaya, Victor A., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 P Street, Building 640
WPAFB OH 45433-8865

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/ENS/01M-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The impact the Next Generation Small Loader (NGSL) will have on reducing the mobility footprint has not been thoroughly explored. AMC is currently exploring a Non-developmental Item (NDI) loader in the NGSL. The NGSL combines the capabilities of the 25K Loader and the Wide Body Elevator Loader (WBEL). This technology, coupled with the new Tunner 60K Loader, will improve cargo loading and unloading efficiency by providing highly mobile, flexible, and reliable MHE capable of servicing all types of cargo aircraft. This study is an analysis of how the NGSL will benefit cargo-loading operations by reducing the mobility footprint, in terms of manpower, operating cost, aircraft loading times, aircraft capacity, and vehicle authorizations.

15. SUBJECT TERMS
Cargo Handling (BT)
Cargo Vehicles (UF)
Loaders (BT)
Materials Handling Equipment (RT)

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dr. William A. Cunningham AFIT/ENS
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

Form Approved
OMB No. 074-0188